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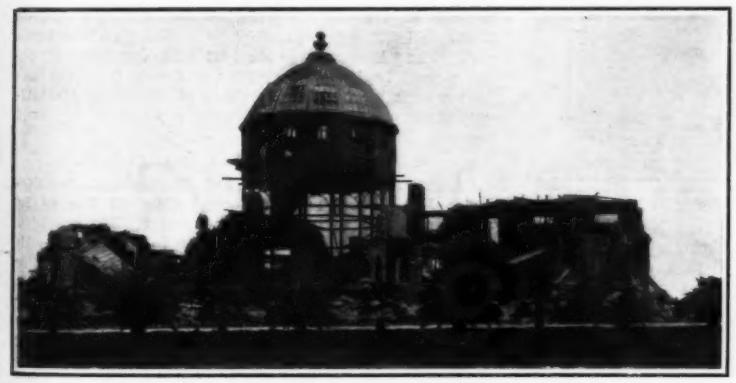
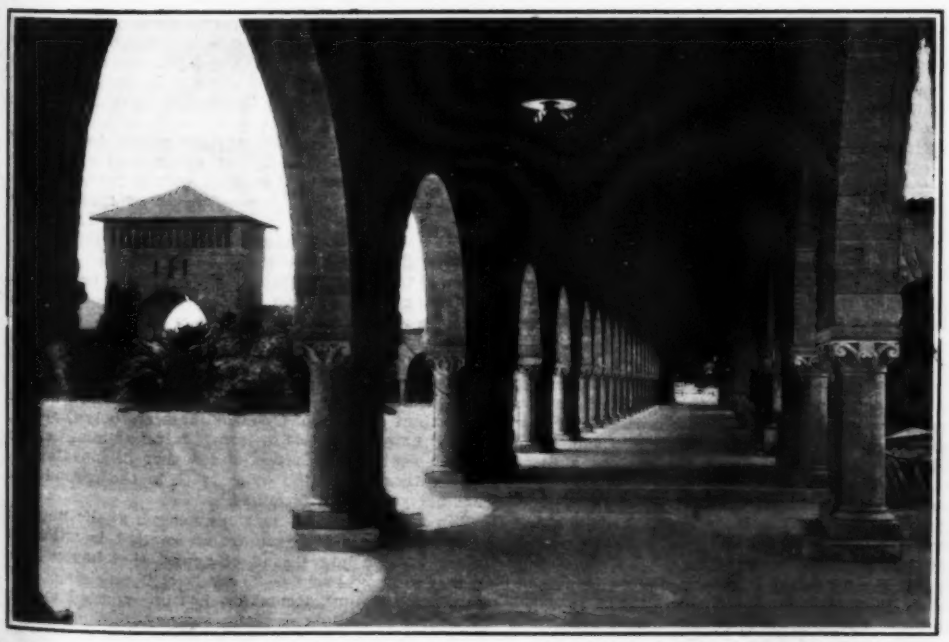
THE MEMORIAL CHURCH BEFORE THE EARTHQUAKE

THE CHURCH AFTER THE CATASTROPHE.

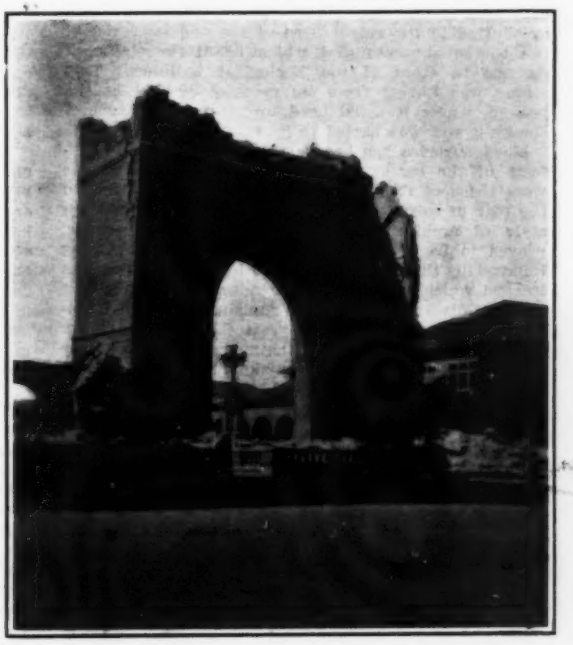


THE RUINED LIBRARY.

THE PRESENT CONDITION OF THE COURTWAY.



CORRIDOR OF LELAND STANFORD, JR. UNIVERSITY, SHOWING ARCH TO THE LEFT BEFORE EARTHQUAKE.



MEMORIAL ARCH AFTER THE EARTHQUAKE.

THE RUINS OF LELAND STANFORD, JR., UNIVERSITY.

THE RUINS OF LELAND STANFORD, JR., UNIVERSITY.

IN the greater disaster of San Francisco, the damage done to the small towns in the neighborhood of that city has been largely overlooked. In many of these towns the sufferings and privations endured by the stricken inhabitants were almost as great as those of the San Francisco victims, the chief difference being that the communities affected were much smaller and less dense. Of these, the one to which the greatest interest attaches is probably the little town of Palo Alto, thirty-five miles southeast of San Francisco, for the reason that here the Leland Stanford, Jr., University is located. Six weeks ago Stanford University was classed as the most beautiful university in the world, owing to its charming location and picturesque and harmonious architecture. The central buildings of the University were patterned after the old Spanish missions of that region. They are low structures built of buff sandstone and covered with red tile roofs. The buildings are arranged in two quadrangles, one within the other. The inner one is made up of twelve single-story buildings, which are connected by a continuous arcade and face a court 586 feet long by 246 feet wide. These buildings contain the administrative offices and the Departments of Law, Mathematics, and Languages. Connected by corridors with the inner quadrangle is the outer quadrangle, which also consists of twelve buildings connected by a continuous open arcade, but most of these buildings are two-story structures. In this quadrangle are the Departments of Science, Engineering, Economics, History, and English. The Library and Assembly Hall also form part of this quadrangle. The dormitories, shops, laboratories, gymnasium, etc., comprise a number of detached buildings about the outer quadrangle.

The Memorial Arch and the Memorial Church were the most striking features of the outer quadrangle, and on these two "show" pieces of the University, the recent earthquake seemed to expend its greatest spite. The Memorial Arch was originally 100 feet high and 90 feet wide with a span of 44 feet, and it was decorated by a frieze 12 feet high, designed by St. Gaudens. Now it is badly damaged above and below the frieze and one foot is shifted at the base. It is also badly cracked. The Memorial Church was a grand structure of Moorish Romanesque architecture. The steeple of the church rose to a height of 188 feet. The interior of the building was ornamented with most beautiful and costly mosaics, and the church was furnished with a magnificent organ of 46 stops, 3,000 pipes, and a set of chimes. The destruction of this magnificent building is well told by our illustrations. The steeple toppled over and fell through the roof, carrying with it a mass of wreckage into the body of the church. The clock was left intact, supported by a beam in the tower. The mosaic of "The Sermon on the Mount" was hurled to the pavement, leaving the organ loft exposed. Fortunately the organ was but little damaged.

Another building to suffer severely from the earthquake was the new $800,000 library, which was still in course of construction. The walls of this building collapsed and the roof fell in. The Chemistry Building suffered mainly from a tall chimney, which broke about 20 feet from the base. The engineer was caught in the fall and killed. The dormitories and most of the residence buildings on the campus were badly injured by the earthquake, mainly owing to the fall of chimneys. Only one student was killed, although a great many were badly hurt by the collapse of a chimney of Encina Hall. The Museum was also badly wrecked, many valuable collections being lost, the only part that can be saved being the collections of the Indian room and the Memorial room, also Mrs. Stanford's paintings. The Egyptian collection and the costly Venetian glasses are a total loss. Fears are also expressed for the valuable Australian paintings, which are buried in the ruins. One of the oddest freaks of the earthquake was that which befell the statue of Agassiz in front of the Zoological building. This statue was hurled from its pedestal 30 feet to the ground, where it dived head foremost into a cement sidewalk and was buried to its shoulders.

Much surprise has been expressed at the severe effects of the earthquake on buildings constructed as were those of Stanford University. It was owing to the fear of seismic disturbances that the low Mission style of architecture was adopted. This, however, proved to be of little avail under the inertia strains imposed by the earthquake. One lesson, however, was learned which will be of importance in the rebuilding of the University structures, namely, that high chimneys must be avoided, as a great deal of the damage done was due to the fall of chimneys. The first hysterical reports of the earthquake placed the loss to the University at nearly $3,000,000. This estimate has since been greatly modified. President David Starr Jordan believes that the injury to the working buildings can be repaired at a cost of $200,000. Most of the damage done affected the "show" buildings, but even these, it is estimated, can be restored at an expenditure not exceeding half a million dollars.

Linoleum for Cement Floors.—To make linoleum adhere to a cement floor, a glue is used which has been boiled until it is of the consistency of carpenters' glue, and to which sifted wood ashes have been added, stirring, to make a mass resembling varnish. Apply to the lower side of the linoleum, and press hard against the floor.—Die Werkstatt.

THE FIND AT OXYRHYNCHUS.

DRS. B. P. GRENFELL and D. A. S. Hunt have discovered among the ruins of Oxyrhynchus in Egypt a fragment of vellum supposed to be a lost gospel, which is now in Queen's College, Oxford, and over which much controversy is likely to arise. The find is wormeaten, but perfectly legible, being written in Greek characters almost microscopically minute. It contains about three hundred words, describing a conversation in the temple between Jesus and a Pharisee. It was at Oxyrhynchus that excavators found the Logia of Christ a few years ago.

It turns out that the excavations of Drs. Grenfell and Hunt have yielded many writings equal in importance to the gospel fragment. The New York Evening Post publishes the following complete narrative of the discoveries, written by the archæologists themselves, and forwarded to Prof. Thomas Day Seymour at Yale University. It follows:

"After four winters spent in excavating the site of Oxyrhynchus, and when most of the earlier rubbish-mounds had been dug down to the level at which papyrus ceases to be preserved, it was hardly to be hoped that discoveries of literary papyri on a quite exceptional scale were still in store for us. Fortune, however, as the event proved, had reserved her most precious gifts until the fifth season, the results of which surpass even those of the first excavators at Oxyrhynchus in 1897.

"The mounds, of which the excavation had for various reasons been postponed until last winter, are situated in the central portion of the site. Only in one comparatively small group of these was it certain that papyri earlier than the fourth century would be forthcoming near the surface. In the other mounds the Roman layers were known to be more or less deeply buried under Byzantine accumulations dating from the fifth century onward. Hitherto all the chief finds of literary papyri at Oxyrhynchus have been made in the earlier strata, and the experience of former years had not led us to expect very much of importance either

THE STATUE OF AGASSIZ IN ITS PRESENT POSITION.

from fifth to seventh century rubbish, in which literary pieces are generally scarce, or from the deeper levels in which papyri of any description tend to be in very poor condition.

"Since it was uncertain whether a continuance of the excavations would be possible in the future, we were anxious to turn over as much ground as possible; and for the greater part of fourteen weeks over 200 men and boys were employed, instead of the usual 120. With a largely increased number of hands it is not surprising that last season's papyri, which range from the second century B. C. to the sixth century A. D., occupy 131 boxes compared with 91 and 117 filled in the two preceding seasons. But, what is much more important, the quality of the new finds is not less remarkable than their quantity.

"In a rich site such as Oxyrhynchus it is not uncommon to come upon large groups of papyri which have been thrown away simultaneously. These finds generally consist either of letters, accounts, and contracts belonging to one or more private individuals, or else of multifarious official documents from the local archives, while literary fragments are as a rule conspicuous by their absence. Not until last season has any excavator had the good fortune to make a find of this extensive character in which the papyri, instead of being non-literary, had emanated from a scholar's library.

BROKEN LITERARY PAPYRUS.

"The first occasion on which this occurred was on January 28, when we were excavating one of the few remaining Roman mounds. Shortly before sunset we reached at about six feet from the surface a place where in the third century a basketful of broken literary papyrus rolls had been thrown away. In the fading light it was impossible to extricate the whole find that evening; but a strong guard was posted on the spot during the night, and the remainder was safely removed in the following forenoon. Before being condemned to the rubbish-heap the papyri had as usual been torn up; but amid hundreds of smaller fragments there were a couple of cores of rolls, containing ten or twelve columns, several pieces containing five or six, and many more one or two.

"How far the pieces will fit together is still uncertain, for the papyri only reached England at the end of April, and we have not yet been able to decipher more than a few of the larger fragments. But it is probable that they can be combined to some extent, although the task of fitting them together will inevitably be slow. It is therefore impossible as yet to form an exact estimate of the value of the find; but, leaving the small fragments out of account, the MSS. which are represented by one or more of the longer pieces number ten, all belonging to the second or third century. Two of these are poetical, both fortunately nonextant and by authors of the highest rank, Pindar and Euripides.

"The Pindar papyrus contains, principally at any rate, Pæans, i. e., odes of supplication or thanksgiving addressed to a god, and their authorship is proved by a coincidence with an already known Pindaric fragment. The text is accompanied by elaborate explanatory scholia. So far we have extracted nine practically complete columns of about fifteen lines; and there are parts of a good many more. Since the existing fragments of the Pæans amount to a bare dozen lines, the papyrus practically introduces us for the first time to this class of Pindar's compositions.

SERIES OF POETICAL FRAGMENTS.

"The second series of poetical fragments is from a roll containing a tragedy on the subject of Hypsipyle, which on the strength of certain features in the plot as well as of style, we have little hesitation in identifying with the Hypsipyle of Euripides. The scene of the drama is laid at Nemea, and the characters occurring or mentioned are Hypsipyle herself, her two sons (Euneus and Thoas), Amphiaraus, and probably Parthenopæus (two of the seven heroes who took part in the expedition against Thebes), and Lycurgus, King of Nemea. The portions of the text recovered up to the present amount to about 100 complete or nearly complete lines, mainly lyrical, but this number will, we hope, eventually be considerably increased.

"Of the prose MSS. several belong to extant works, two containing the Phædrus, and one the Symposium of Plato, the last being the longest papyrus of the find; a fourth has the speech of Demosthenes against Bœotus, a fifth the Panegyricus of Isocrates. Of a MS. of the orations of Lysias one piece contains the conclusion of the speech against Hippotherses, which is lost, and the beginning of that against Theomnestus, which is extant. By far the most valuable of the prose pieces is part of a new history of Greece. The longest fragment of this has not yet been unrolled, but one of the other pieces is concerned with the relation of parties at Corinth to Argos and Sparta in the period succeeding the battle of Nemea in B. C. 394, and in connection with the Corinthian general, Timolaus, refers to two otherwise unrecorded incidents in the Peloponnesian war. It is clear from the style of the fragment that it belongs to a historical work on a large scale and of first-rate importance, possibly by Ephorus or Theopompus. The other new prose text is a commentary on the second book of Thucydides, different from the extant scholia, and, since the views of Dionysius of Halicarnassus are criticised, probably a work of the first century.

REMAINS OF A SECOND CLASSICAL LIBRARY.

"A few days after this find of literary texts we discovered the remains of a second classical library in another mound. In this, the fourth to fifth century layers reached down to a level of 10 to 15 feet, beneath which were the Roman strata, extending below the crest of the mound to a depth of 30 feet. Here about 8 feet from the surface we came upon a thin layer which throughout an area of many square yards was full of literary fragments, while stray pieces belonging to the same texts were found some distance away. The evidence of documents found below the literary texts shows that the latter must have been thrown away in the fifth century, but the MSS. themselves are chiefly of the second or third century. Compared with the first literary find, the second is in point of bulk more than twice as large, and the MSS. probably exceed thirty in number; but as a whole it is hardly likely to prove so valuable, since the papyri have been much more broken up.

"A hexameter poem of twenty-two lines in praise of Hermes is complete, and there are several pieces containing more than one column of writing; but it is doubtful whether continuous sheets of much length can be built up out of the innumerable fragments, which range in size from some lines to a few letters. This is the more regrettable because the owner of the library was much interested in the lyric poets. His collection included two or three MSS. apparently of Sappho, and one of the dithyrambs of Bacchylides (attested by the title of the roll which still adheres to part of the ode of Theseus), as well as a MS. of the meliambi of Cercidas. Since one fragment of the last-named work contains upward of seventy lines and in the extant remains of Cercidas there are only fourteen, it will now be possible to form a fairer estimate of the fourth century B. C. poet-philosopher of Megalopolis. The authorship of the other MSS. in the second find has not yet been determined.

"In another part of the same mound, at the unusual depth of twenty-five feet, we made what is with one exception the largest find of papyri that has yet occurred at Oxyrhynchus. The bulk of it consists of first to second century documents, but interspersed among these are many literary pieces, some of which are fairly long. Being affected by damp, the surface of most of these papyri requires cleaning before continuous decipherment is possible.

THE VELLUM LEAF OF GOSPEL.

"While these three principal finds necessarily overshadow the other discoveries of the season, they too present many points of interest. In particular, one of the Byzantine mounds yielded pages from fourth to sixth century books of papyrus or vellum in unprecedented numbers. Among these pieces of classical or theological works we may signalize a leaf from a Latin papyrus MS. of the Catiline of Sallust, and a vellum leaf (forty-five lines in all) from a MS. of a lost Gospel. The subject of this is a visit of Jesus with his disciples to the temple at Jerusalem and their meeting with a Pharisee, who reproaches them with their failure to perform the necessary ceremonial of purification before entering the holy place. After a question and answer, in which the Pharisee describes in some detail the formalities which he had himself observed, Jesus makes an eloquent and crushing reply, contrasting outward with inward purity. There is a certain resemblance between this and the denunciation of the Pharisees in Matthew xxiii, 25, and Luke xi, 37; but the whole incident, of which the account is practically complete and very striking, is quite different from anything recorded in the Gospels. Among the most remarkable features of the fragment are its cultivated literary style, the picturesqueness and vigor of the phraseology, which includes several words not found in the New Testament, and the display of a curious familiarity—whether genuine or assumed—with the topography of the temple and Jewish ceremonies of purification. The question of the nature and value of the Gospel to which this fragment belongs is likely to provoke much controversy."

The next memoir of the Græco-Roman excavation branch is Part I. of the Hibeh Papyri, which will appear in a few weeks. The publication of the chief literary papyri from the new finds will begin in Part V. of the Oxyrhynchus Papyri, to be issued in 1907, and will be continued in succeeding volumes of the same series. Meanwhile, funds are needed by the Branch in order to complete the excavation of all the more promising portions of Oxyrhynchus before the concession for the site is given up. For this object at least one season's work is necessary. Subscriptions may be sent to Prof. Seymour, Yale University, who is one of the honorary vice-presidents for America. Subscribers of $5 are entitled to the annual volume.

SIMPLE TESTS FOR THE DETECTION OF FOOD ADULTERANTS.*

INTRODUCTION.

GENERALLY speaking, the methods of chemical analysis employed in food laboratories can be manipulated only by one who has had at least the usual college course in chemistry, and some special training in the examination of foods is almost as necessary. Again, most of the apparatus and chemicals necessary are entirely beyond the reach of the home, and the time consumed by the ordinary examination of a food is in itself prohibitive.

Yet there are some simple tests which serve to point out certain forms of adulteration and can be employed by the careful housewife with the reagents in her medicine closet and the apparatus in her kitchen. The number may be greatly extended by the purchase of a very few articles that may be procured for a few cents at any drug store. In applying these tests, one general rule must always be kept carefully in mind. Every one, whether layman or chemist, must familiarize himself with a reaction before drawing any conclusions from it. For instance, before testing a sample of supposed coffee for starch, the method should be applied to a sample of pure coffee (which can always be procured unground) and to a mixture of pure coffee and starch prepared by the operator.

Many manufacturers and dealers in foods have the ordinary senses so highly developed that by their aid alone they can form an intelligent opinion of the nature of a product, or of the character, and sometimes even of the proportion, of adulterants present. This is especially true of such articles as coffee, wine, salad oils, flavoring extracts, butter, and milk. The housewife finds herself constantly submitting her purchases to this test. Her broad experience develops her senses of taste and smell to a high degree, and her discrimination is often sharper and more accurate than she herself realizes. The manufacturer who has developed his natural senses most highly appreciates best the assistance or collaboration of the chemist, who can often come to his relief when his own powers do not avail. So the housewife, by a few simple chemical tests, can broaden her field of vision and detect many impurities that are not evident to the senses.

There are here given methods adapted to this purpose, which may be applied to milk, butter, coffee, spices, olive oil, vinegar, jams and jellies, and flavoring extracts. In addition to this some general methods for the detection of coloring matter and preservatives will be given. All of the tests here described may be performed with utensils found in any well-appointed kitchen. It will be convenient however, to secure a small glass funnel, about 3 inches in diameter, since filtration is directed in a number of the methods prescribed. Filter paper can best be prepared for the funnel by cutting a circular piece about the proper size and folding it once through the middle and then again at right angles to the first fold. The paper may then be opened without unfolding in such a way that three thicknesses lie together on one side and only one thickness on the other. In this way the paper may be made to fit nicely into the funnel.

* Abstract of a monograph by W. D. Bigelow and Burton J. Howard, published by the Department of Agriculture.

Some additional apparatus, such as test tubes, racks for supporting them, and glass rods, will be found more convenient for one who desires to do considerable work on this subject, but can be dispensed with. The most convenient size for test tubes is a diameter of from one-half to five-eighths inch and a length of from 5 to 6 inches. A graduated cylinder will also be found very convenient. If this is graduated according to the metric system, a cylinder containing about 100 cubic centimeters will be found to be convenient; if the English liquid measure is used it may be graduated to from 3 to 8 ounces.

CHEMICAL REAGENTS.

The word "reagent" is applied to "any substance used to effect chemical change in another substance for the purpose of identifying its component parts or determining its percentage composition." The following reagents are required in the methods here given:

Turmeric paper.
Iron alum (crystal or powdered form).
Hydrochloric acid (muriatic acid) concentrated.

Caution.—All tests in which hydrochloric acid is used should be conducted in glass or earthen ware, for this acid attacks and will injure metallic vessels, such as iron, tin, zinc, etc. Care must also be taken not to bring it into contact with the flesh or clothes. If by accident a drop of it falls upon the clothes, ammonia, or in its absence a solution of saleratus or sal soda (washing soda), in water, should be applied promptly.

Iodin, tincture.
Potassium permanganate, 1 per cent solution.
Alcohol (grain alcohol).
Chloroform.
Boric acid or borax.
Ammonia water.
Halphen's reagent.

With the exception of the last reagent mentioned, these substances may be obtained in any pharmacy. The Halphen reagent should be prepared by a druggist rather than by an inexperienced person who desires to use it. This is especially important because of the inflammable nature of carbon bisulphid which enters into its composition.

Caution.—Carbon bisulphid is a very inflammable substance and is at least as dangerous to handle as gasoline. For this reason the Halphen reagent, into the composition of which carbon bisulphid enters, must be handled with care, and only a small portion of it taken into the vicinity of the fire. When it is employed the end of the test tube may be loosely stoppered with cotton. The carbon bisulphid in the amount of reagent used for a single test, however, is so small as not to cause any particular danger in its use.

Halphen's reagent is prepared as follows: An approximately 1 per cent solution of sulphur is made by dissolving about one-third of a teaspoonful of precipitated sulphur in 3 or 4 ounces of carbon bisulphid. This solution mixed with an equal volume of amyl alcohol forms the reagent required by the method. A smaller quantity than that indicated by these directions may of course be prepared.

If turmeric paper be not available it may be made as follows: Place a bit of turmeric powder (obtainable at any drug store) in alcohol, allow it to stand for a few minutes, stir, allow it to stand again until it settles, dip a strip of filter paper into the solution, and dry it.

DETERMINATION OF PRESERVATIVES.

The following methods cover all of the more important commercial preservatives with the exception of sulphites and fluorids. These are quite frequently used for preserving foods—the former with meat products and the latter with fruit products—but, unfortunately, the methods for their detection are not suitable for household use.

DETECTION OF SALICYLIC ACID.

The determination of salicylic acid can best be made with liquids. Solid and semi-solid foods, such as jelly, should be dissolved, when soluble, in sufficient water to make them thinly liquid. Foods containing insoluble matter, such as jam, marmalade, and sausage, may be macerated with water and strained through a piece of white cotton cloth. The maceration may be performed by rubbing in a teacup or other convenient vessel with a heavy spoon.

Salicylic acid is used for preserving fruit products of all kinds, including beverages. It is frequently sold by drug stores as fruit acid. Preserving powders consisting entirely of salicylic acid are often carried from house to house by agents. It may be detected as follows:

Between 2 and 3 ounces of the liquid obtained from the fruit products, as described above, are placed in a narrow bottle holding 5 ounces, about a quarter of a teaspoonful of cream of tartar (or, better, a few drops of sulphuric acid) is added, the mixture shaken for two or three minutes, and filtered into a second small bottle. Three or four tablespoonfuls of chloroform are added to the clear liquid in the second bottle and the liquids mixed by a somewhat vigorous rotary motion, poured into an ordinary glass tumbler, and allowed to stand till the chloroform settles out in the bottom. Shaking is avoided, as it causes an emulsion which is difficult to break up. As much as possible of the chloroform layer (which now contains the salicylic acid) is removed (without any admixture of the aqueous liquid) by means of a medicine dropper and placed in a test tube or small bottle with about an equal amount of water and a small fragment—a little larger than a pinhead—of iron alum. The mixture is thoroughly shaken and allowed to stand till the chloroform again settles to the bottom. The presence of salicylic acid is then indicated by the purple color of the upper layer of liquid.

Detection of Benzoic Acid.

Benzoic acid also is used for preserving fruit products. Extract the sample with chloroform as in the case of salicylic acid; remove the chloroform layer and place it in a white saucer, or, better, in a plain glass sauce dish. Set a basin of water—as warm as the hand can bear—on the outside window ledge and place the dish containing the chloroform extract in it, closing the window until the chloroform has completely evaporated. In this manner the operation may be conducted with safety even by one who is not accustomed to handling chloroform. In warm weather the vessel of warm water may, of course, be omitted. Benzoic acid, if present in considerable amount, will now appear in the dish in characteristic flat crystals. On warming the dish the unmistakable irritating odor of benzoic acid may be obtained. This method will detect benzoic acid in tomato catsup or other articles in which it is used in large quantities. It is not sufficiently delicate, however, for the smaller amount used with some articles, such as wine. It is often convenient to extract a larger quantity of the sample and divide the chloroform layer into two portions, testing one for salicylic acid and the other for benzoic acid.

Detection of Boric Acid and Borax.

Boric acid (also called boracic acid) and its compound with sodium (borax) are often used to preserve animal products, such as sausage, butter, and sometimes milk. For the detection of boric acid and borax, solids should be macerated with a small amount of water and strained through a white cotton cloth. The liquid obtained by treating solids in this manner is clarified somewhat by thoroughly chilling and filtering through filter paper.

In testing butter place a heaping teaspoonful of the sample in a teacup, add a couple of teaspoonfuls of hot water, and stand the cup in a vessel containing a little hot water until the butter is thoroughly melted. Mix the contents of the cup well by stirring with a teaspoon and set the cup with the spoon in it in a cold place until the butter is solid. The spoon with the butter (which adheres to it) is now removed from the cup and the turbid liquid remaining strained through a white cotton cloth, or better, through filter paper. The liquid will not all pass through the cloth or filter paper, but a sufficient amount for the test may be secured readily.

In testing milk for boric acid 2 or 3 tablespoonfuls of milk are placed in a bottle with twice that amount of a solution of a teaspoonful of alum in a pint of water, shaken vigorously, and filtered through filter paper. Here again a clear or only slightly turbid liquid passes through the paper.

About a teaspoonful of the liquid obtained by any one of the methods mentioned above is placed in any dish, not metal, and 5 drops of hydrochloric (muriatic) acid added. A strip of turmeric paper is now dipped into the liquid and then held in a warm place—near a stove or lamp—till dry. If boric acid or borax were present in the sample the turmeric paper becomes bright cherry red when dry. A drop of household ammonia changes the red color to dark green or greenish black. If too much hydrochloric acid is used the turmeric paper may take on a brownish red color even in the absence of boric acid. In this case, however, ammonia changes the color to brown just as it does turmeric paper which has not been dipped into the acid solution.

Detection of Formaldehyde.

Formaldehyde is rarely used with other foods than milk. The method for its detection in milk is given later. For its detection in other foods it is usually necessary to first separate it by distillation, a process which is scarcely available for the average person without laboratory training and special apparatus. For this reason no method is suggested here for the detection of formaldehyde in other foods than milk.

Detection of Saccharin.

Saccharin has a certain preservative power, but it is used not so much for this effect as because of the very sweet taste which it imparts. It is extracted by means of chloroform, as described under the detection of salicylic acid. In the case of solid and semi-solid foods, the sample must, of course, be prepared by extraction with water, as described under salicylic acid. The residue left after the evaporation of the chloroform, if a considerable amount of saccharin is present, has a distinctly sweet taste.

The only other substance having a sweet taste which may be present in foods, i. e., sugar, is not soluble in chloroform, and therefore does not interfere with this reaction. Certain other bodies (tannins) which have an astringent taste are present, and as they are soluble in chloroform may sometimes mask the test for saccharin, but with practice this difficulty is obviated.

(To be continued.)

According to the German Postverband the number of picture post cards sent in the different countries of the Postal Union in 1905 was as follows: Germany, 1,061,000,000; America, 770,000,000; England, 613,600,000; Japan, 487,000,000; Austria, 291,000,000; British India, 254,000,000; Russia, 114,000,000; Belgium, 63,000,000; Hungary, 88,000,000; France, 70,000,000; Italy, 85,000,000; Low Countries, 59,000,000; Switzerland, 53,000,000; Sweden, 43,000,000; Spain, 13,000,000; Portugal, 11,000,000; Denmark, 6,000,000, and Norway, 5,000,000.

[Continued from SUPPLEMENT No. 1585, page 25394.]

RESERVOIR, FOUNTAIN, AND STYLOGRAPHIC PENS.—VII.*

By JAMES P. MACINNIS, A.M.Inst.C.E., M.Inst.Mech.E.

FOUNTAIN PENS.

THE feed bar, F. C. Brown, 1894 (10838), in Fig. 161 carries the nib, *N*, between two tongues, and it extends rearward in the form of a rod, *B*, through the plug, *P*, which is screwed into the other end of the ink reservoir, *A*. When the pen is out of use the nib is drawn into the nozzle of the reservoir by means of the sliding ring, *R*, attached to the rod, *B*. The cap, *C*, is then screwed on the front end forming an air-tight joint, and preventing leakage of ink when carried in the pocket.

In Fig. 162, F. S. Cocker, 1894 (22469), shows another adaptation of the flexible reservoir to force the ink to the nib. It will be seen that the flexible tube, *B*, extends from the lower end of the ink reservoir, *A*, to the feed bar, a short portion of it projecting on the underside of the penholder. By pressing this portion, *D*, ink is expelled to the nib, *N*. When the pen is out of use, a cap is pushed over the nib and front end of the penholder, forcing a bent piece, *C*, upward, thus closing the ink outlet.

As everyone knows, Fig. 163 is a drawing of the feed bar of the well-known "Swan" Fountain Pen (1895, 4012, Mabie, Todd & Bard), patented ten years ago. A flexible tube, *E*, is split for the greater portion of its length, and the legs bowed apart as shown. Notches are provided at the end of each leg. The nib is held between the two legs. The grooves in the legs which originally formed the bore of the tube, *E*, serve to carry ink to the nib and air to the ink reservoir, assisted by the bright surface of the wire, *H*, running through the bore of the tube.

A patent was granted in April, 1895, to J. Glass (7199), for a fountain penholder having a flexible rubber ink reservoir, terminating in a tubular glass ink feeder. By pressing the flexible reservoir on the surface visible through the opening in the outer protecting casing, ink is made to flow to the nib.

The nozzle or point section, *B*, in Fig. 164, W. W. Stewart, 1895 (13566), is screwed into the ink barrel, or reservoir, *A*. The thickened end of a stopper bar, *F*, fits into the end of the nozzle eccentrically, leaving a crescent-shaped opening into which the nib, *C*, is inserted, and held firmly by the top feed bar, *D*. Ink flows down to the nib and through openings around it as shown. The stopper bar, *F*, is hollow and slit longitudinally to establish ink communication between the nib and the reservoir. The bore of the bar, *E*, is partly filled by a wire, *F*, having a spherical knob on its outer end, by means of which the feed may be adjusted.

In Fig. 165, H. Brams, 1896 (1029), the ink is contained in the flexible rubber bag or reservoir, *C*, and supplied to the nib through the upturned opening, *D*. A metal case protects the reservoir, and has an opening at *F*, while a plate, *E*, extends all along the parallel portion of *C*, between it and the cover. The cap is formed with a blunt point which when inserted in the hole, *F*, forces the plate, *E*, against the reservoir, *C*, thus compressing it. On its release a supply of ink may be drawn into the reservoir.

This invention, I. Golwer, 1896 (2189) relates more particularly to the method of controlling the supply of ink to the nib. The ink is contained in the back part of the holder and passes forward through the tube. By depressing the rear end of a lever the valve is raised, and ink flows outward along the feeder to the nib.

In another pen, C. J. Renz, 1896 (16733), ink is contained in a reservoir, having an air inlet at its upper end. The ink outlet is opened by pushing back the ink conducting piece, thus moving a valve from its seat. Ink then flows along a spiral groove to the neck, and thence along other grooves filling pockets, which are connected in pairs by holes, and it finally passes along the feeder to the nib.

Fig. 166, W. Schlomberg, 1896 (25441), shows yet another piston-action pen. The reservoir is filled with ink by withdrawing the hollow tubular plunger, *C*, the point, *G*, having been immersed in ink. On covering the outlet, *G*, and opening the air inlet, *I*, the plunger may be pushed into the barrel, *A*. The ink guide, *H* is then replaced in the orifice, *G*, as shown, in such a position as to conduct the ink to the nib.

The pen shown in Fig. 167 (29072, Heinzelmann and Schwarz, 1896) has a valve, *V*, of conical form and two or more channels for the ink, which may be partially or completely closed by screwing in the part, *D*, which is formed at its lower end to fit *V*.

The specification of this inventor, E. Reisert, 1897 (924), shows a variety of forms of feeding arrangements, from which I have selected as an illustration the one shown in Fig. 168. An intermediate chamber, *A*, formed of flexible rubber, is placed between the ink reservoir, *I*, and the nib, *N*. It is connected with the reservoir by a tube, *E*, having a valve opening downward, and at the lower end it is connected with the nib by a tube, *O*, having an opening at its side which is normally closed by the spring valve, *S*, opening outward. In use the flexible chamber, *A*, is lightly pressed so that the valve, *E*, is closed and the valve, *S*, is opened, thus forcing a supply of ink to the nib. On relieving the pressure the valve, *S*, automatically closes, and valve, *E*, opens admitting a fresh charge of ink to the chamber, *A*.

Fig. 169 (Bryant & Townsend, 1897, 11516) is a self-filling pen, similar in some respects to others. When sufficient ink has been drawn into the reservoir by the withdrawal of the glass tubular plunger, *D*, it is allowed to flow into the hollow plunger, which is then pushed downward into the holder. The ink passages between the reservoir and the nib, *C*, are not shown, but I would call attention to the annular passage at the bottom of the reservoir being completely closed by the plunger, *D*, thus making the pen safe to carry in the pocket without fear of leakage, the plunger being firmly screwed down by means of the cap, *K*, to which it is secured.

Another inventor essays to produce a piston pen (W. C. Sherman, 1897, 19760). The piston is operated by a sliding case connected to the piston-rod which is screwed into the plug at its upper end.

In Fig. 170 (A. Oidtmann, 1897, 20199), the nib, *C*, is held in place by the elastic ball, *F*, which entirely closes the ink outlet when the nib is withdrawn. The nib is provided with grooves which conduct the ink to the point.

Another pen, Sugden & Wild, 1897 (21948), is one in which the ink is forced to the nib as required. The screwed piston rod carries a pin which slides in a slot. By rotating one part on the plug, the piston is advanced, and forces ink through the feeder to the nib.

Fig. 171 (W. T. Shaw, 1897, 25764) shows a pen in which the reservoir, *A*, is fitted with a screw plug or point section, *C*, into which is fitted a second plug, *D*, having an ink duct, *I*, and an air inlet, *E*, between the points of which the nib is held. The rod, *R*, may be screwed down by means of the cap, *K*, so as to completely close the ink passage.

The drawing, Fig. 172 (G. H. Lock, 1898, 4491) is that of the feed point in section. The ink-holding tube, *A*, is closed by a disk having holes as shown. The plug, *C*, is provided with an air channel, *I*, and an ink duct, *K*. This plug can be rotated in the collar, *F*, so that the holes, by a hit and miss arrangement, become covered, thus either cutting off or allowing the flow of ink as desired.

The ink reservoir in Fig. 173 (S. N. B. Westlake, 1898, 7277) is closed at one end by a screw plug, and supplies ink to the nib, *D*, through the curved duct, *C*. The nib is held beneath the loose sleeve, *E*. The essence of simplicity certainly, but probably its simplicity is fatal to its satisfactory working.

This pen (Weeks & Morch, 1898, 12244), is designed so that the supply of ink to the nib can be cut off by rotating the head, thus raising the piston, and bringing the valve tight against its seat. Wires are attached to the nib, and extend slightly behind it, and by their vibration are intended to prevent clogging of the channel with ink.

(To be continued.)

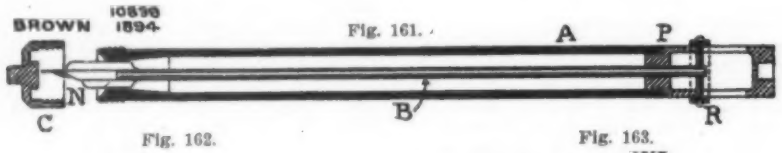


Fig. 161.

Fig. 162.

Fig. 163.

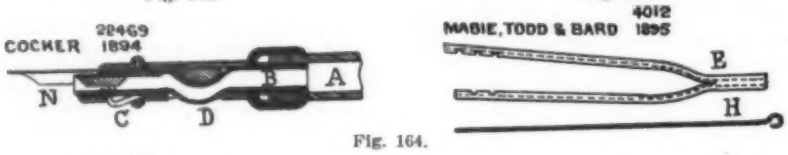


Fig. 164.

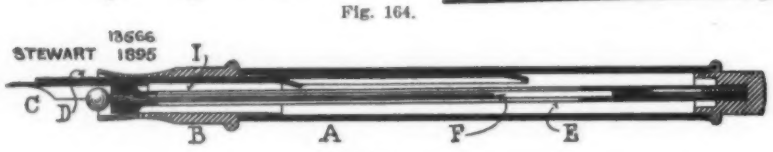


Fig. 165.

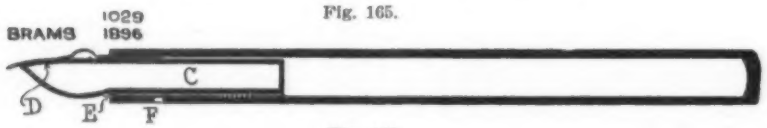


Fig. 166.

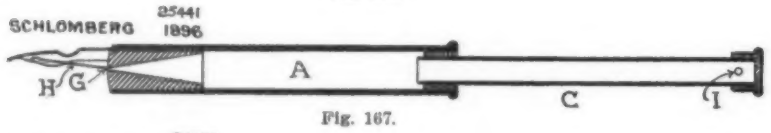


Fig. 167.

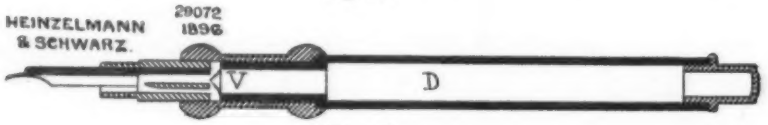


Fig. 168.

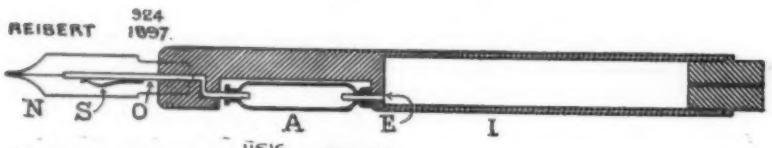


Fig. 169.

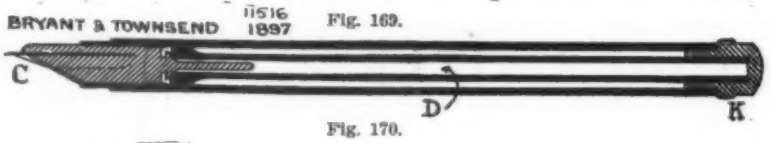


Fig. 170.

Fig. 171.

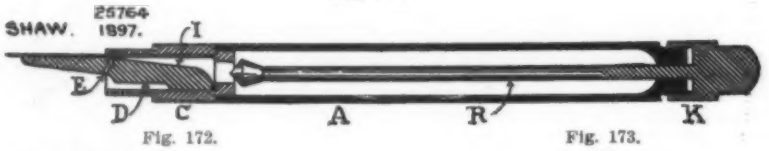
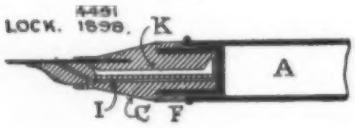
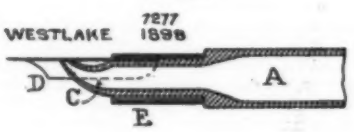


Fig. 172.

Fig. 173.





The manufacture of cement in the United States continues to make remarkable progress. Whereas in 1890 there were sixteen factories, producing annually 335,000 barrels of Portland cement, there were, in 1905, eighty-two plants, with an estimated annual output of 31,000,000 barrels. The manufacture has increased about a hundredfold in sixteen years, for in 1889 the total production was 300,000 barrels.

* Journal of the Society of Arts.

THE UTILIZATION OF SOLAR HEAT FOR INDUSTRIAL PURPOSES BY MEANS OF A NEW PLANE MIRROR REFLECTOR.*

By CARL GÜNTNER.

MR. M. A. MOUCHOT advises us, in the Comptes Rendus of the Parisian Academy of Sciences (lxxxi, 1871), concerning an apparatus constructed by him for the utilization of solar heat for practical industrial purposes.

Essentially, this consists of the surface of a straight truncated cone, of which the generatrix is inclined 45 deg. to the axis, and which carries a small cylindrical boiler which lies concentric with the axis of the cone. When in use the mouth of the cone is turned toward the sun in such a manner that its prolonged axis will strike the middle point of the sun, causing those sun's rays, which fall into the funnel, to be reflected, by its polished surface, perpendicularly upon the boiler.

That Mr. Mouchot should have been able to generate sufficient steam with his conical reflector, which possessed a heating or rather concentrating surface of four square meters, to run a small model steam engine, is by no means a matter for surprise, for, with an ordinary tin funnel having an opening of only 16 inches, I brought three ounces of cold water, contained in a one-inch tube situated upon the axis of the cone, to a violent boil in fifteen minutes.

In spite of its apparently favorable operation the conical reflector is adapted for small heating effects only, for the practical application of solar heat demands not only the production of correspondingly high temperatures, which may be easily generated by burning-reflectors or burning-glasses, but also a constant delivery of considerable quantities of heat.

Such a delivery of heat can be effected only by means of an enormous concentration of the sun's rays, for, according to Pouillet, the absolute amount of heat given off by a plane reflector upon which the rays fall perpendicularly is on the average only 3.4 calories per square foot per minute, while in the ordinary furnaces for industrial purposes from 4,000 to 100,000 calories are produced in the same unit of time.

Let us suppose then that 50 per cent of the absolute heat can be made useful, which, considering the important sources of loss that arise, such as faulty reflection, absorption, radiation, and cooling, is a very favorable figure; in order to produce the heating effect of 60 pounds of coal, we should be obliged to construct a conical reflector having a diameter of 100 feet.

Fig. I

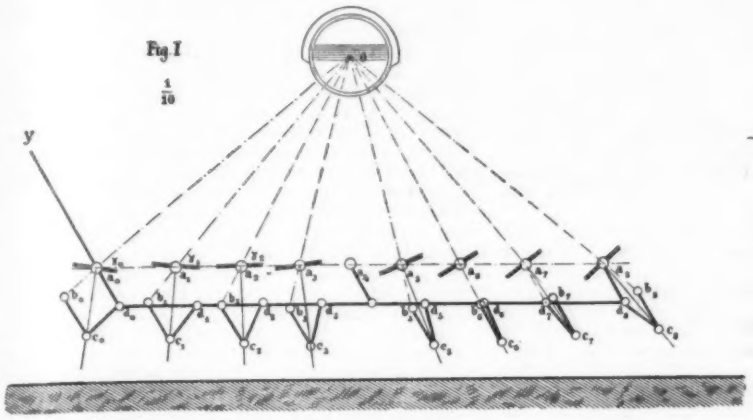


Fig. III.

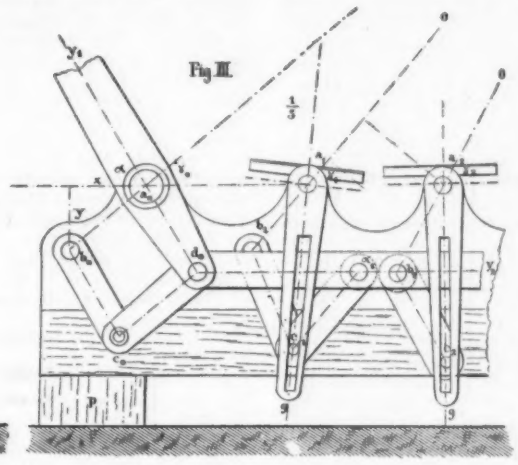
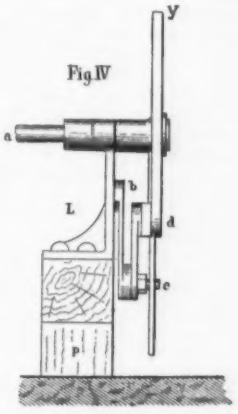
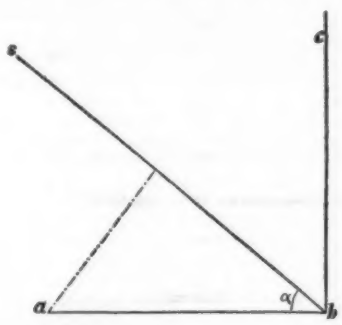


Fig. IV



More practical still would be a cylindrical surface with a cross section in the form of sectors of the circle. True, this would not concentrate all the rays upon a straight line, but with a correct choice of the radius in comparison with the subtending chord of the arc of cross section this deviation would be of small importance, since the reflected rays must fall upon the surface of the tube to be heated, of which the axis coincides with the burning line and the diameter of the tube should not be less than 4 sec. to 5 sec.

During the sun's motion, the burning line describes



a cylindrical surface which lies concentric with the surface of the reflector; from this we see that channels of circular-shaped cross section may be permanently fixed upon their base provided the tube to be heated be movable about the axis of these surfaces, a condition which greatly simplifies the construction of the apparatus, since the small boiler is much easier moved than the huge reflector.

For details concerning the calculation relative to the effective work of such reflectors I beg to refer to a small work of mine bearing the title "Ueber die Benützung der Sonnenwärme zu Heizeffekten," published in Dingler's polytechnishem Journal, vol. 173, page 418, 1864.

By means of the experiments which I carried out with reflecting channels, both of circular and parabolic form, at Laibach in 1854, and also through comparative studies on the prime cost of various methods of constructing reflectors and from the coefficients, for the determination of the probable effectiveness of such reflectors, which I obtained, I have arrived at the conclusion that the sun's rays may only be made serviceable for industrial purposes when it is possible to concentrate them at low cost and in immense quantities.

The construction of a reflector which shall fulfill all these requirements, as also all the demands of practice, is then the indispensable prerequisite to the successful solution of the problem.

The method of constructing a reflector which I proposed in 1864, and which was on view in 1873 at the Vienna Exposition in the pavilion for Austrian inventions, fulfilled for the most part these conditions; it possessed, however, the disadvantage common to all sheet-metal reflectors, that to maintain the surface in proper condition when exposed to all sorts of weather requires careful and costly attention.

Being convinced, however, that the exploitation of solar heat will come more and more into vogue, even in spite of the disadvantageous periodicity of this source of warmth, I have taken the trouble to put aside the evil mentioned above, and overcome it by an entirely new method of reflector construction. By the application of the recent and cheaper methods of manufacturing glass mirrors, I have succeeded in producing a plane mirror reflector which fulfills all requirements that can be made of such an apparatus and at the same time lies within practical limits. This plane reflector consists of a larger number of long, narrow mirrors placed at suitable distances from one another, and which, when upon level ground, lie parallel with each other horizontally, extending either from north to south or from east to west.

Each one of these mirrors revolves about a horizontal axis, and by means of a simple parallelogram motion may be made to follow the sun in such a manner that all the sun's rays falling upon the plane mirrors may be reflected upon the surface of a tube or boiler the long axis of which lies also in the plane of the mirror axis.

Fig. I. shows the geometrical framework of such a mirror; only eight mirrors are provided, with a view to retaining the drawing within certain convenient limits.

Fig. II. shows a plan view of the same wherein the length of the mirror is left unlimited, and for that reason both tube and mirrors are shown broken away.

Figs. III. and IV. show the parallelogram motion in detail at about one-fifth of the natural size.

Fig. V. finally shows the details of the sustaining frame for the mirror leaves.

In Fig. I. a_0 a_1 a_2.... are the mirror axes which must be considered as standing erect upon the surface of the paper. o is also the boiler axis, likewise perpendicular.

Now if we draw from the middle point o of the boiler o to a_0 a_1 a_2. . . . the radii a_0o a_1o a_2o. . . . and extend these from a_0 a_1 a_2.... to any desired and fixed distance a_0 $b_0 = a_1$ $b_1 = a_2$ b_2.... we shall get the points b_0 b_1 b_2 .... which are to be considered fixed points so long as the axis of the boiler o remains unchanged with regard to the axes a_0 a_1 a_2 .... of the mirrors.

The light rays which are drawn through the points of the axes of the mirrors a_0 a_1 ...., form plane sur-

Fig. II.

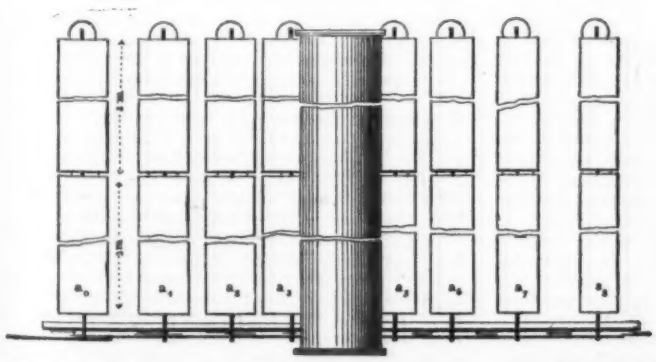


Fig. V.

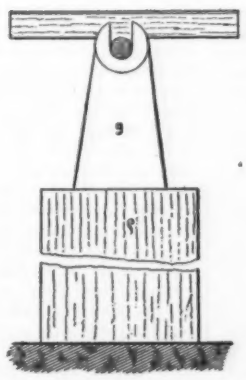
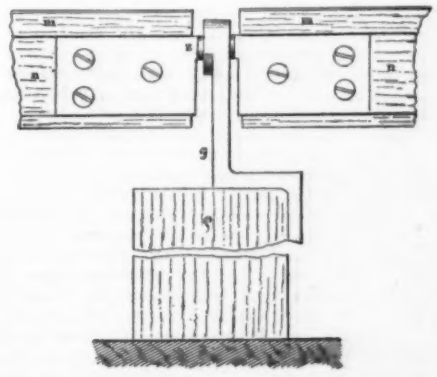


Fig. VI.



The building of such a huge funnel of tin, with its enormous bearings and the heliostat mechanism, at all times necessary to keep it perpendicular to the sun, not to mention the necessary stiffening to enable it to withstand wind and storm, would bring its initial cost so high that its application on a large scale would have to be abandoned.

After my first experiments, and having made comparative calculations of the cost of plant, relative to the results to be obtained, I recognized this at once

* Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from vol. lxxii. of the Proceedings of the K. Akad. der Wissensch., I. Abth.

faces perpendicular to the surface of the drawing and cut it in parallel right lines. They are shown at $a_0\ y$ (Fig. I.) which gives their direction for a certain position of the sun. Now if we draw through $a_1\ a_2\ a_3$ .... parallels to $a_0\ y$, extending these lines the same distance from $a_0\ a_1\ a_2$ .... making $a_0\ b_0 = a_0\ d_0 = a_1\ d_1 = a_2\ d_2$ .... and complete the rhomboids $a_0\ b_0\ c_0\ d_0$, $a_1\ b_1\ c_1\ d_1$, $a_2\ b_2\ c_2\ d_2$, then will the diagonals of these rhomboids form the section of the normal plane of incidence with the surface of the drawing, while the radii $a_0 o\ a_1 o\ a_2 o$ .... will form the sections of the plane of reflection, if we imagine mirror or reflecting surfaces, which are perpendicular to the diagonals, joined to the axes. Consequently, all sun's rays which fall upon these mirror planes must be thrown back upon the boiler and they will pass bundles of rays in the directions $a_0 o\ a_1 o\ a_2 o$ .....

The concentration does not occur in a single straight line, but since the reflections from the mirror strips are thrown upon a narrow portion of the boiler o and cover each other at that point they will effect the greater elevation of the temperature according as the number of these reflecting surfaces is increased. Let us imagine the sides of the rhomboids stiff lines and the points $b_0\ c_0\ d_0$, $b_1\ c_1\ d_1$....hinge points and $d_0\ d_1\ d_2$ .... a rigid line joined at its center and d_0 with a_1 and a_2 by pivot joints. Then all the mirrors would assume the correct positions whenever the direction of $a_0\ y$ corresponds with the position of the sun, viz., is perpendicular to the central point of the sun, provided at the same time we consider the diagonals fixed at right angles to the mirror surfaces.

Figs. III. and IV. show how these theoretical conditions may be practically carried out, thus furnishing the detailed construction of the rhomboid mechanism for the correct placing of the mirrors. The fixed points are determined as given above and $a_0\ b_0\ c_0\ d_0$ is the first parallelogram, by means of which the motion will be transmitted to the others in the following manner. From d_0 a horizontal bar passes to y_1, and, for the fixing of the position it is joined at its center and d_0 with a_1 and a_2 as far as d_2, Fig. 1. Situated upon the bar, at distances corresponding exactly with the centers of the mirror axes, are the hinge points d_1, d_2 .... and the links $b_0\ c_0$, $c_0\ d_0$, $b_1\ c_1$, $c_1\ d_1$ .... complete each separate rhombus.

The pillow block, L, Figs. III. and IV., carries the fixed points $b_0\ b_1\ b_2$ .... and furnishes at the same time support for the bearings of the mirror axes. The pillow blocks are bolted to a beam which, in its turn, is made fast to a heavy stable frame p .....

Upon the projecting ends of the mirror axes are placed rings or collars which are made fast to the mirror axes by setscrews.

Connected with these rings are the directing links $a_1 c_1\ \ a_2 c_2$ ..... These links are further provided with long slots in which pins, projecting from the hinge joints, work.

These slots, and also the links in which they are, assume, at every change in the position of the rhombi, the direction of their respective diagonals, which, being permanently fixed to the mirror axes perpendicular to the plane surface of the mirrors, thus also determine the position of the mirrors, whenever the directing bar $a_0\ y_1$ is so thrown that its shadow falls upon the prolongation of said axes, or rather of the first axis, since there is but one actual directing bar, the others being wholly imaginary.

The determination of the fixed points $b_0\ b_1$ .... cannot be effected by a drawing on a large scale. They must be found by calculation. If then d represent the distance of any desired axis a_n from a vertical plane through o, and h the height of the center o above the plane of the mirror axis and r the length of one side of the rhombus, we shall have or can construct the right-angled triangle $x, y, a_0\ b_0$ shown at Fig. III., then will

$$x = \frac{d\,r}{\sqrt{h^2 + d^2}} \text{ and } y = \frac{h\,r}{\sqrt{h^2 + d^2}}$$

The points $b_0\ b_1\ b_2$.... would naturally lie in the conchoid, if the distances between the centers of all the mirror axes were the same. This is not the case in the accompanying sketch; these distances are rather chosen so that the impinging rays may be unobstructedly reflected upon the boiler.

Should the distances between the mirror axes be the same, then, for a certain angle of incidence, a portion of the reflected rays would be caught up by the rear wall of the mirror next adjacent.

Since, however, when carrying out the scheme upon a large or practical scale the equality of all dimensions of a similar nature presents obvious advantages, it is found more practical to space these axes at equal distances apart, but to make the distances somewhat in excess of the width of the reflecting mirror.

In Figs. V. and VI. we show the details of construction of the carrying frame of the reflecting strips. m is a wooden strip 12.7 centimeters wide, 3 meters long, and 2.6 centimeters thick screwed to the board n to prevent shrinking. Between every two such supporting strips or ribs is provided a pivot, z, cast to a plate which is screwed as shown to the rib, said pivot having its support in the fork bearing, g, which is carried by the frame, ρ. Upon the upper surface of these ribs are placed strips of cloth upon which the mirrors are laid and fastened by means of spring clamps.

All the mirrors of one or several reflectors may be served by one man, who has only to place the directing lever in such a way that its shadow falls upon its own axis. Just how easy it will be to construct such a plane mirror reflector of large dimensions may be best set forth by a few words in which I shall sketch out the mounting.

Blocks of selected stuff 2×4, having a length depending upon the number of mirror strips desired, are fastened to the heavy wooden frame arranged upon the ground so that they point east and west. Upon the first block is fixed the bearing for the parallelogram motion; upon all the others, a fork-bearing block is to be fixed, all arranged in rows running from north to south, having their axis centers in a direct line with the axis center of the directing bar bearing. This done, the bearing frame of the mirror will be laid in the extreme bearing and the mirror clamped on, and so with the next and the next until the mirror or reflector is complete.

At the center of the frame, supports for the boiler must be erected. Upon their upper ends they carry semicircular bearings for the accommodation of the boiler. Now, after the mirrors and the boiler have been properly and securely mounted, the parallelogram mechanism may be adjusted to its bearings, whereupon the proper placing of the reflecting planes with regard to the slots in the guiding arms may be accomplished with the aid of any ordinary apparatus for measuring angles.

Immediately to the rear of each bearing the axis of the mirror is provided with a detachable coupling whereby, by a simple movement of a hand lever, all the mirror axes may be simultaneously turned through an arc of 180 deg., which means that all the mirrors may thus be made to look toward the ground, and be in this way protected from the destructive action of sudden falls of hail.

This is an important advantage of our reflector, which can only be fully appreciated when we consider the difficulties which must be overcome in other constructions before so great a surface can be protected against a sudden hailstorm. Since the coupling, detaching mechanism, and adaptability to turn through 180 deg. offer nothing new in the way of construction, we have not found it necessary to supply the details of the same.

Moreover, be it said that in this reflector the forked bearings, pivots, bearing frames, links, guide bars, supports, bolts, and mirror strips are interchangeable among themselves; the parts may therefore be so cheaply made that taking the present prices of material into consideration, such a mirror reflector may be built at the rate of 5 florins (about $2) per square yard of reflecting surface.

Concerning the calculation for effectiveness, the following remarks may be permitted. Since the mirrors do not lie in a position exactly perpendicular to the direction of the sun's rays, and since in calculating the effectiveness of a reflector only the perpendicular cross section of a bundle of rays which are reflected upon the surface of the boiler may be considered, it is above all else of prime necessity to establish the effectiveness of a single mirror strip during a day, or a specified part of a day, of sunshine.

Referring again to Fig. III., we see that mirror a_1 reflects all the rays which fall upon it upon the boiler in the direction $a_1 o$, and since in plane mirrors the reflected bundle of rays is not condensed, the perpendicular cross section of this bundle of rays may enter into the calculation.

Let t be the time elapsed since sunrise, and α the corresponding angle which the sun's rays make with the horizontal plane during this elapsed time; thus $a_0\ y_1$, Fig. III., the direction of the rays after the lapse of the time t, γ_t (gamma) the angle which the ray $a_1 o$ makes with the horizontals, f the width of the mirror a_1, e the amount of useful heat dispensed per unit of surface per minute, W the effectiveness of the mirror within a certain period of time, and T the time from sunrise to noon. Provided with all the above elements, the mere mathematical working out of the problem is easy, so easy that we shall not transcribe it here. Nevertheless, though the determination of the effectiveness of a single mirror be a matter of no great difficulty, the full effect of a combination of such mirrors presents several complications which are harder to dispose of. It would be by no means correct to multiply the effectiveness of one mirror by the number of mirrors in use, for not only does the angle γ (gamma) vary for each mirror, but no single mirror is constantly delivering its maximum output, for the mirrors are for a part of the time in the shadow of those which immediately precede them, and besides when the axes are equally spaced the back of one mirror obstructs some of the rays coming from that mirror next further from the sun. These theoretical speculations are, however, of little value, since they do not lead to any formulæ suitable for practical use. Let then the following simple formula suffice: $W = 1.59\ f\ T$ calories (see Dingler vol. 173, page 426). Here f is to be expressed in square feet and T in minutes.

If 6.60 be substituted for its equivalent T, then the daily effectiveness will be found with sufficient exactness to be $W = 57.24\ f$.

According to this, then, a reflector presenting 1000 □° of surface would deliver as many calories as 4,400 pounds of coal, in fact something in excess of this, because the reflecting effect of glass mirrors is considerably greater than burnished tin or metal, for which the value $e = 1.3$, which I discovered, is used in the above calculations.

The advantage to be obtained from the application of such a reflector depends chiefly upon the number of sunny days in the year, and though the field of application is considerably curtailed by virtue of the insurmountable periodicity of sunshine and darkness, yet there are, especially in southern latitudes, many forms of applying a reflector of this type from which, and with a large measure of probability, success may confidently be expected. Among others it might be used for irrigating purposes, for it is upon sunny and hot days that this is highly necessary.

The boiler will furnish the steam for a pump which in its operation will lift the water from a lower to a higher level.

Since no intermediate machinery is required here, and, with the exception of the adjustable mirrors, all else is permanently fixed, this reflector in combination with an ordinary steam pump composes the simplest form of water lifter conceivable, a machine capable at the same time of delivering water in large quantities.

In Egypt, where the productiveness of the soil is so greatly enhanced by irrigation from the Nile, that the fellahin are forced to pay heavy taxes on their water wheels; where the sands of the desert often cover basins of subsurface water; and where these waters coming to the surface produce the rank vegetation of the oases; there, under the powerful rays of an almost equatorial sun, is where the establishment of water-lifting reflector plants may be looked forward to with the greatest assurance of success; and since by the multiplication of the number of the mirrors, the temperature may be raised to almost any desired point, its application for many other purposes where heat is required becomes possible.

On many of the sugar plantations the sap is not completely expressed from the cane, in order that the latter may be used to feed the boilers, a necessity caused by the scarcity of fuel in the vicinity; here would be another favorable opportunity for the application of a reflector for heating purposes.

In the manufacture of sea salt, in the salt gardens the salt is profusely mixed with earth. Were a reflector used for driving off the water in a boiler or huge vat, the salt from the sea water would be obtained perfectly white and clean; moreover, by utilizing every sunshiny hour the production of salt would be greatly increased.

Redtenbacher, in his works on machinery, says: "The solar heat is the motive force for all organic life. What water and steam power are to the economy of industry, the warmth of the sun is to the plant world. But this beneficent heat is not for our industrial being because we have no means at hand for concentrating considerable quantities of the warmth given off by the sun within a small compass."

In my plane-mirror reflector I believe I have discovered the means, and permit myself accordingly to recommend it to the consideration of the Academy of Sciences.

APPENDIX.

Concerning the Application of Solar Heat to Practical Uses.

According to the pyrheliometric measurements of Althaus and Pouillet (see Poggendorff's Annalen, vol. xlv., pages 25 and 481) a surface a foot square will receive 3.4 calories of heat per minute if it be placed perpendicular to the rays of the sun. The heat which reaches the earth from the sun daily could accordingly raise 10 billion cubic meters of water from 0 deg. C. into steam at 100 deg. C., producing thus the heating effectiveness of five billion hundredweight of coal.

Allowing 7 pounds of coal per horse-power hour, and taking into consideration that our steam engines only deliver 1-22 of the effective force of the heat generated, then the total effective energy of the solar heat per second will amount to 66 billion horse-power.

Disregarding the fact that these figures present us with a picture of the gigantic mechanical energy delivered by the sun's warmth, they also lead up to the thought that as much as possible of such energy should be made serviceable for industrial purposes.

True, the variability of sunshine is a very important disadvantage; but so is the power of the wind variable, and yet we have harnessed it to our mills and made it serve our purposes in many ways.

Bear in mind that in the southern portions of the temperate zone and in the tropical regions, the seasons of rain and sunshine relieve each other with remarkable regularity; remember further that, by concentrating the solar rays, considerable degrees of heat may be produced; and moreover, that, according to the data furnished above, it requires but 200 square feet of surface to generate steam sufficient for one horse-power. With this in view, then, it may not be uninteresting to bring under closer consideration the query how best to exploit this source of heat.

First of all, the practical application of the solar heat requires a suitable apparatus, one which will effect the concentration of the sun's rays in enormous quantities, and be at the same time easily constructed on a large scale. It is apparent that the burning mirrors and lenses which have hitherto been used in school experiments are of no value for the purpose. The inner surface of a straight cone or funnel would serve much better, because it deflects all the rays which fall upon it, parallel with its axis, into the axis itself.

If we place, for instance, in the axis of a conical funnel of burnished tin a tube, fill it with water, and hold the opening of the funnel toward the sun so that the tube cast no shadow, the water will begin to boil violently in from six to ten minutes, provided the base of the funnel measures 16 inches and the tube is of 1 inch diameter, containing about 6 ounces of water at 14 deg. C. There are no special difficulties in the

way of increasing the mouth of the funnel to any desired diameter, for tin funnels with an opening from 10 to 12 feet are surely much easier made than a spherical burning mirror of like diameter; but, since such a reflector must correspond always with the position of the sun, that is, constantly retain its axis parallel with the incidental rays, and to impart this motion to it requires a complicated heliostatic mechanism, it becomes evident that only under most favorable conditions would such a conical reflector be applicable. With the cone thus eliminated the choice remains only between the parabola or the ordinary cylindrical surface. The former concentrates all rays which fall upon it parallel with the plane of its axes, directly and exactly upon the axes. In this case it is immaterial whether the sun's rays lie perpendicular or oblique to the axis of the reflector, and for this reason, in the application of a reflector of this kind, only a very simple motion would be required to cause the reflecting surface to continually correspond with the position of the sun.

For example, if the burning axis should be directed north and south, only an east and west motion would be required; but if the burning axis be situated horizontally in the direction east and west, and the plane of the axis be vertical, only a motion about its vertical axis would be needed.

In the region of the equator, if the position of the reflector be such as last described, there will be no need for any mechanical movement of the reflecting surface, because the plane of the reflector's axis coincides with the plane of the sun's path.

If a tube or boiler be placed in the burning axis of, and permanently fixed to the surface of such a shell of parabolic cross section, then the rays of the sun will be concentrated upon the surface of the tube, and, provided the tube or boiler has been filled with the proper material, effective heating of the contents will result. In order to attain a certain degree of temperature, the ratio of the diameter of the boiler to that of the reflector must be carefully considered. If we make the accumulation of the temperature upon the surface of the boiler proportional to the degree of concentration of the solar rays, then the temperature of the boiler may be expressed by the equation $T^\circ = \frac{l}{s} . t^\circ$

where s represents the width of the reflecting surface, l the length of the arc upon which the rays are to be concentrated, and t the temperature indicated by a thermometer exposed to the sun at the time.

We have shown that with a tube of from 3 inches to 4 inches and a reflecting gutter about 3 feet wide we can boil water. In this case, then, the temperature must be above 100 deg. C.

By means of several such reflectors arranged in parallel the concentrating surface could be increased at will; but we have also pointed out that only in the vicinity of the equator could reflectors of this description be permanently fixed. For all other points upon the earth a steady motion of the reflector would be necessary, and this would require a very costly mechanism. There remains, then, only the ordinary cylindrical surface; it is indisputably the best for the purpose, particularly since it permits of a fixed position and may be carried out even on a large scale at a comparatively low cost.

Imagine such a shell of circular cross section so placed upon the ground that its hollow surface be turned toward the sun, lay out a plane through the middle point of the sun and the axis of the cylindrical reflector, then will all the rays falling parallel with this plane be concentrated upon a straight line which lies in the plane of the axis and parallel with the surface of the cylinder. The distance of this focal line is, as we know, $\frac{R}{2}$ when R is the radius of the cylindrical surface.

During the progress of the sun, the focal line describes a cylindrical surface having a diameter equal to $\frac{R}{2}$, and hence the sun's rays will be constantly reflected upon a tube, whenever such a tube shall be set in motion in such a manner that its axis always coincides with the focal line.

We have determined then that *gutter reflectors of circular cross section may be permanently fixed whenever the heated tube is movable.*

If the axes lie in the direction of east and west, the necessary circular movement of the heated tube will, in general, be very slight; it develops into a slow oscillation about the axis of the reflector, and may be mechanically accomplished with ease.

It is scarcely necessary to remark that these reflectors do not throw back all the rays exactly upon the axis of the shell; nevertheless, when the radius R and the diameter d of the boiler, and the width s of the shell are correctly selected, the variation which arises may be neglected, being too small for serious consideration. For example, then, with $R = 5$ feet, $s = 5$ feet, and $d = 4$ inches, even the extreme rays will be concentrated upon the surface of the boiler.

Now that the cylindrical reflectors may be securely and immovably fixed upon the ground, it becomes necessary to provide its surface with a sufficient degree of stiffness to prevent any alteration in its shape.

In my opinion a very cheap method of producing reflectors of this sort would be as follows: Run sheets of thin steel through a pair of rollers. Upon one of the rollers provide semi-circular ribs, upon the other cause hollows of like size and shape to be cut, into which the ribs fit nicely and run truly. When the plate emerges from between the rollers, it will not only have attained a semi-cylindrical form, but it will be in a manner corrugated. It is not necessary to have the corrugations very close together.

Run lead in the hollows on the concave side of the reflector, smooth off evenly, and give the whole a good coating of tin; the back may be covered with any good preservative against oxidation. In this way, provided the necessary machinery is at hand, reflecting surfaces measuring six feet across and of a like length may be constructed at a moderate cost. If thin metal be selected, a reflecting surface 6 feet square should weigh scarcely more than 30 pounds, and ought to cost but about 5 florins ($2). By piecing the sheets together nicely, the size of the reflector could be increased indefinitely. If the shapes of these gutters are maintained exactly alike, the movement of the tubes to be heated will be regular; and if water only is to be turned into steam, the tubes may be joined at the top and bottom by a pair of parallel headers. The whole system of pipes may then be suspended from fixed points which lie in the plane of the cylinder axes or carried upon supports provided with rolls. I do not purpose to give a detailed description of the boiler or its mounting here, for the sole object of this article is to show the possibility of concentrating huge masses of the sun's rays upon a certain point and doing it easily and at a low cost.

Having the reflectors, we must now determine the effective heating force. First of all, then, we must remember that during a day of sunshine the reflecting surface, horizontally placed, is reached by the rays under varying angles, and the mass of rays falling upon the reflector is accordingly variable; this mass may, however, be taken as proportional to the perpendicular cross section of that bundle of rays which is caught at any specified instant by the reflecting surface. I shall call this cross section the catching surface.

Furthermore, the effect of heat upon a surface perpendicular to the incident rays is by no means constant; according to Pouillet, it changes with the thickness of the stratum of air through which it passes. Since, meanwhile, the law for this dependence is not yet completely determined, and since moreover other accidental influences modify this effectiveness, we shall base the following calculation for effective work solely upon the mean value of the heating power of a surface upon which the rays fall perpendicularly. Now let e represent the average number of heat units which may be made available from a unit of surface shone upon perpendicularly during a unit of time, and $a\,b$ the cross section of a horizontal reflector of the size f.

During t units of time after sunrise the rays will fall upon this surface at an angle expressed by α, and the time from sunrise to midday will be represented by T.

Under the angle of incidence, α, the catching surface will be equal to $f \sin \alpha$; and since the catching surface may be considered invariable for the infinitely small space of time dt, we may express the working effect during this infinitely small lapse of time by the equation:

$$d\,W = e f . \sin \alpha . dt. \qquad (1)$$

But we found above,

$$\frac{t}{T} = \frac{\alpha}{\frac{\pi}{2}} \text{ or } t = \frac{2}{\pi} . T . \alpha.$$

Wherefore,

$$d\,t = \frac{2}{\pi} . T . d\,\alpha. \qquad (2)$$

Now substitute for $d\,t$ in equation (1) its value in equation (2) and we shall have:

$$d\,W = \frac{2}{\pi} . e f T . \sin \alpha . d\alpha. \qquad (3)$$

If this latter equation be integrated within the limits α and β we shall then obtain

$$W = \frac{2}{\pi} e f\,T . \int_{\alpha}^{\beta} \sin \alpha . d\,\alpha =$$

$$\frac{2}{\pi} e f\,T \Big(- \cos \beta - (- \cos \alpha) \Big) =$$

$$\frac{2}{\pi} e f\,T\,(\cos \alpha - \cos \beta) \qquad (4)$$

When $\alpha = 0$ and $\beta = 90$ we shall get

$$W = \frac{2}{\pi} e f\,T.$$

Now if the mirror be not exposed under the equator, but rather under some geographical parallel β deg., then the highest point of the sun during the day will be 90 deg. to β deg., and the equation must be solved between the limits $\alpha = 0$ deg. and $\alpha = 90 - \beta$ deg.

In the expression $W = \frac{2}{\pi} e f\,T\,(\cos \alpha - \cos \beta)$ the true value of e must be found by trial.

Pouillet found for the latitude of Vienna that e would average 3.4 calories per square foot per minute, but this means the total output of a unit of surface; this value cannot, however, be used as a basis for any calculation of work where such important sources of loss are present. Such losses arise from imperfect reflection, incomplete absorption, radiation of heat, and the cooling of the heated surface by the cooler air circulating about it. Some of these losses may be in a way minimized, but they can never be entirely obviated. Hence it is necessary to discover that value of e which affords the unit of heat that can be made available for effective service from a square foot of catching surface per minute.

Being deprived of the experience of any former experimenter in this direction, I myself made appropriate trials with reflectors of similar construction but of much smaller dimensions. In order to avoid any misrepresentation concerning the exactitude in the construction of the reflector I employed, I shall give here a detailed description of it.

The two opposite sides, each 3 feet long, of a wooden right-angular frame, having a width of 1 foot and a length of 3 feet, were hollowed out to correspond with a previously designed parabolic template, and upon the parabolic curve thus established two sheets of white tin were nailed. Four supports, which were fastened to the sides of the frame, carried a 3½-inch tube erected in such a manner that its axis coincided with the burning axis of the reflector. This tube was closed at both ends, painted black on the outside and furnished with a blow-off pipe. During the experiments the surface of the reflector was continuously held toward the sun, so that the axis of the shadow of the tube coincided perfectly with the vertical line of the reflecting surface while the plane of the retaining frame remained perpendicular to the sun's rays. The catching surface presented a superficial area equal to 3 square feet.

A strip of paper held in the axis plane near the tube was intensely illuminated in places, which disclosed the fact that the concentration was far from complete—indeed, tolerably imperfect.

A more careful reconstruction was purposely omitted, in order that the results of this test might not turn out more favorable than could be expected from a similar construction on a larger scale; for the same reason also was the tin only cleansed from dust and dirt, all efforts at a high polish being neglected.

Both before and after each experiment the water in the boiler was weighed, and the time of the boiling was only taken when the blow-off pipe emitted streams of steam with considerable force.

The following small table gives the average results of a number of tests which I conducted with this reflector during the months of August and September:

Time of Day.	Ounces of Water.	Temperature of Water Before Exposure	Time Required to Boil, in Minutes.	Duration of Boiling, in Minutes.	Evaporated Water, in Ounces.	Condition of the Atmosphere.
9-10	16	11.5° C.	19	60	6.6	Very clear.
4-	32	12.0° C.	35	60	6.	Clear.
2- 3		13.0° C.	34	60	6.8	Clear but humid.
10-12	16	12.0° C.	19	120	13.	Cloudy.

From these experiments it has been deduced that the amount of heat given off per square foot per minute is about equal to 1.3 calories.

In his calculations Pouillet made it 3.4, and according to him the efficient energy in the evaporation of water was about 38 per cent.

For our zone, then, the mean value of e may be set down as 1.3.

The effect then of a reflecting surface equal to f in twelve hours would be as follows:

$$W = \frac{2.6}{\pi} . 2\,T . f\,(\cos \alpha - \cos \beta).$$

$$\alpha = 0 \text{ and } \beta = 90 \text{ deg.}$$

$$W = \frac{5.0}{3.14} . 2\,T\,f = 1.59\,f\,T \text{ calories,}$$

in which equations f is expressed in square feet and T in minutes.

A reflector presenting 1,000 square feet of surface would deliver in twelve hours an amount of energy expressed by the equation

$W = 1.59 . 1000 . 36 . 6 . 60 = 20{,}606{,}400$ calories, or an effective force equal to that generated by the consumption of 44 hundredweight of hard coal.

Let us suppose such a reflector in use in the tropics, and that there be a total of two hundred sunny days in the year, the annual energy would therefore be equal to 8,800 hundredweight of coal. Accepting the initial cost to be in the neighborhood of 5 florins ($2) per square yard, and add to this 5 per cent for interest on the capital invested, the heating effect of a hundredweight of coal would come to about 8.8 kreutzers, or a fraction over two cents.

In a general way it is not easy to determine offhand whether the application of such a reflector, from an economical viewpoint, would be advantageous or not; for the prime cost of the apparatus, its transportation to the seat of its usefulness, the number of bright days, the local price of fuel, and other local conditions are all determining factors.

The use of such heat generators would naturally first be considered in southern latitudes, and particularly where the periodical working of the same would have no deleterious effect upon the desired end.

Thus reflectors of this kind, set up in Egypt, to be used for lifting the waters of the Nile to higher planes for the purposes of irrigation, would find special

adaptability; with their boilers they would generate the steam necessary for the supply of a steam engine, and the sun which had scorched the soil of Africa would thus be compelled to moisten it again.

Would not such reflectors be entirely practicable for the operation of periodically working steam boilers in tropical climes? And might they not be advantageously employed in individual cases, even in the temperate zones, for irrigating or evaporating purposes?

The fullest conviction that occasions will arise, more particularly in southern sections, where the above-described employment of solar rays may become of undoubted value, impels me to publish my thoughts concerning the practical application of solar heat, as well as the few experiments I have undertaken in this interest. The consumption of our fuel supply is daily on the increase, and with tireless industry we bore into the bowels of the earth at the risk of life and limb to bring forth the precious coal. Hence it may not be considered superfluous to cast an inquiring eye upon the prime source of all our life-giving warmth, the sun.

A NEW DEVICE FOR THE MAKING OF CURVED STEREOTYPE PRINTING PLATES FOR NEWSPAPERS.*

THE production of the modern newspaper is dependent upon three mechanical processes—the setting of type, which until the advent of the typesetting machine in 1888 was done by hand; the reproduction of the flat type-page, or form as it is called, in many semi-cylindrical printing plates, so that many presses may simultaneously be set to work—a process practised by hand until in 1900 Henry A. Wise Wood set up in the office of the New York Herald his stereotyping machine, the autoplate; and, finally, the printing of the paper itself.

The three operations are essential to the making of all but the smallest newspapers. The type-page must be set, and many reproductions of it must quickly be made. Impatiently waiting printing rooms containing from two to twenty presses must be supplied with from four to forty reproductions of every page, and huge printing machines with their intricate folding mechanisms must be set to reeling off their twenty-four to ninety-six thousand papers an hour.

To one unfamiliar with newspaper work the word haste has no significance. Even the engine-driver straining to make up schedule is a leisurely person when compared with a night editor, a compositor, a stereotyper, or a pressman during those tense and awful moments of "going to press." When the copy for the last item of news is thrust into the compositor's hand, an electric thrill runs through the establishment. "Click, click," and it is in type. "Drop her in!" says the "make-up man." "Lock her up!" cries the "stoneman;' and, with a shout of "Starter!" the page is hurried to the stereotyper, who flings upon it a thick pad of paste-soaked paper and a blanket and shoots it under a molding roller and into a steam oven to bake the soft paper mold into an intaglio representation of the type. This done, out comes the form, off comes the blanket, and the mold, now called a matrix, hard as a board though brittle as glass, is tossed with the magic cry of "Starter!" into the casting room. Here it is caught and thrust into a waiting autoplate, and that automatic machine casts from it at the rate of four a minute semi-cylindrical page-sized printing plates, weighing fifty pounds or more apiece. Then by means of knives, saws, and a variety of other devices it dresses them up and fires them out to a man in waiting, who hurries them to the pressroom with a final cry of "Starter!" where, in an instant, clamped to the cylinders of many presses, they are making two hundred revolutions a minute.

"Going to press" being thus understood, the importance of the work of stereotyping at once becomes apparent. Without it the modern paper could not exist, for to use more than a single printing machine would then be impossible. The utility of the stereotyper's art will be better understood when it is known that during the hours of a Saturday night, for a single edition of the New York Herald, 2,200 or more printing plates, weighing in all well over 110,000 pounds, are made; while at times the New York World's presses before all may be started require some fifty-four plates to be made of each page.

When it is considered that plates such as these must be absolutely perfect in printing surface, so that every type or line of an illustration shall appear, and be absolutely uniform in thickness; and that notwithstanding their accuracy all these plates must be made "on the jump," as the stereotyper has it, the severe demand upon men and mechanism is obvious.

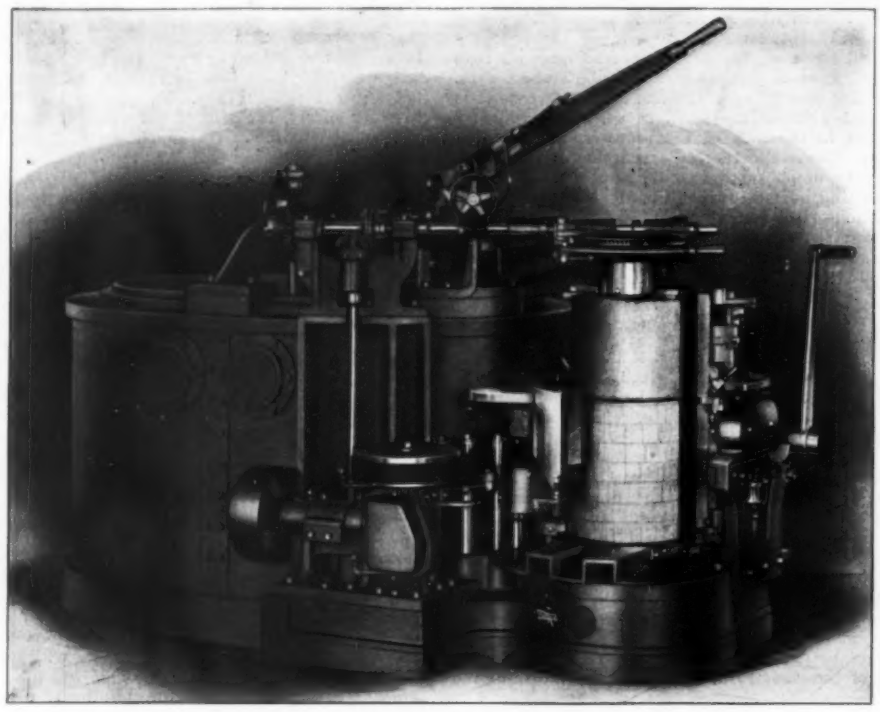
Until the year 1900 stereotyping was exclusively a manually-worked art; from the making of the *papier-maché* mold to the last chisel stroke of dressing a plate every operation of casting, sawing, smoothing out, and finishing was performed by hand or by primitive hand-worked devices. Therefore to practise newspaper stereotyping required great physical strength, unusual endurance; and, because of the fumes and excessive temperatures encountered, the ability to labor under conditions of extreme hardship was a prime requisite.

Such was the condition of the art when in May, 1900, Mr. Wood set his first autoplate to work, and by means of it accomplished with but a few men what theretofore had required many men and over fourfold the expenditure of time.

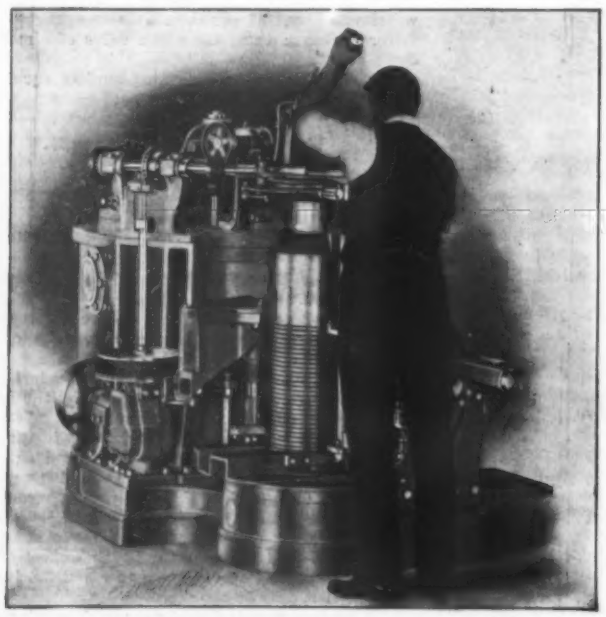
So instant was the success of this revolutionary machine, that the New York Herald, the New York World, the New York Times, the New York Sun, the Chicago Tribune, the Chicago Daily News, the Boston Globe, the Brooklyn Eagle, and other large metropolitan newspapers throughout the United States at once abandoned the making of plates by hand and adopted the autoplate, with a saving to themselves of valuable time, and, in some cases, of as much as $30,000 a year in operating expenses.

Although the autoplate has now revolutionized the work of stereotyping in the offices of the larger newspapers, nevertheless, by reason of the fact that its first cost is large, being $25,000, and its mechanism more or less intricate, only the dailies of the larger cities, with their great volumes of product and their highly-skilled men, have been able to avail themselves of it. This worked against the smaller papers to such an extent that Mr. Wood found it necessary to develop upon the same lines a simpler and less costly machine, for the use of offices where fewer plates are required and whose men are not all thoroughly trained, and this he has succeeded in doing in what he has called the Junior autoplate, which for the first time was exhibited during the convention of the American Newspaper Publishers' Association, held at New York in February last.

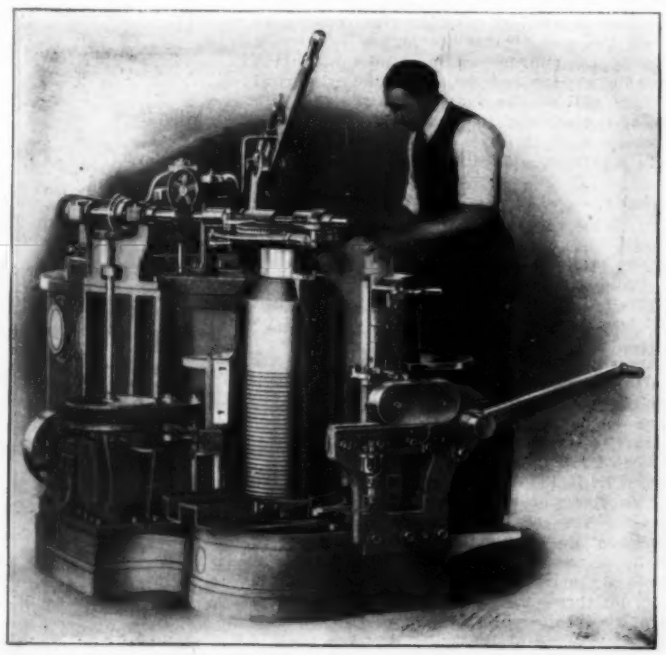
The autoplate itself, a description of which will aid in understanding the other machine, consists of a horizontally disposed semi-cylindrical casting chamber, made up of a cylindrical core and a crescent-shaped back, the space between the two when brought to-



A PLATE HAVING BEEN CAST, SAWED, TRIMMED AND DELIVERED AS SHOWN, THE CHAMBER MAY BE AGAIN CLOSED AND ANOTHER CAST MADE.



BY A SINGLE STROKE OF PUMP LEVER SUFFICIENT METAL IS FORCED INTO THE MACHINE TO MAKE A PRINTING PLATE.



THE WORKMAN SLIPS THE PAPER MATRIX INTO THE CASTING CHAMBER, AND CLOSES IT BY THE LEVER SHOWN.

*Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

gether in a "closed" position being one-half inch, which is the thickness of a printing plate, and covering an area equal to the length and breadth of a newspaper page. At one of the straight sides of this aperture is arranged a nozzle, which connects by means of a throat with a pump immersed in a pot containing about 12,000 pounds of stereotype metal. The back of the casting chamber, which is arranged to rise and fall, in its lower position is far enough away from the core to permit of the insertion of the *papier-maché* mold. A description of the operation of the machine will perhaps sufficiently describe its mechanism. The mold having been set in place, a lever starts the apparatus to work and the back rises, bringing the mold into position with respect to the core, when the pump injects the necessary amount of metal, which is in the neighborhood of fifty pounds. The pump pressure is continued for ten seconds, during which the cooling of the cast is effected by means of a spray playing within the shell of the core and a circulation of water within the back. The cast having solidified, the back drops away and carries with it the matrix, which by means of this motion is stripped from the printing surface of the plate, that is left adhering to the underside of the core. The core then makes half a revolution and brings the printing plate uppermost, while the back again closes upon the underside of the core, and another plate is made. Carrying mechanisms meanwhile remove the first plate from above the core and thrust it, convex side uppermost, through a series of finishing devices which remove its riser, trim up its straight edges, smooth out its under or inner surface, and properly bevel it for the press clamps. The work is so perfectly done that nothing but the type surface of the plate remains high enough to print, and it has been brought to an exact thickness, so that it will properly fit a printing cylinder.

Thus, by means of this machine and three men, printing plates may be made at the rate of four or five a minute, whereas before its introduction from eighteen to twenty men were required for the same work, and but one plate a minute of each page was obtainable.

In his latest invention, the Junior autoplate, Mr. Wood has employed the rotating core and the reciprocating back of his larger machine, but has stood the casting parts on end, so that the axis of the cylinder is vertical, and the casting chamber is filled, as the illustrations will show, by a hand pump, which with one stroke delivers sufficient metal for a plate. In this device the casting chamber is closed and opened by means of a hand lever, but the mold as in the autoplate is mechanically stripped from one cast and repositioned for a succeeding one.

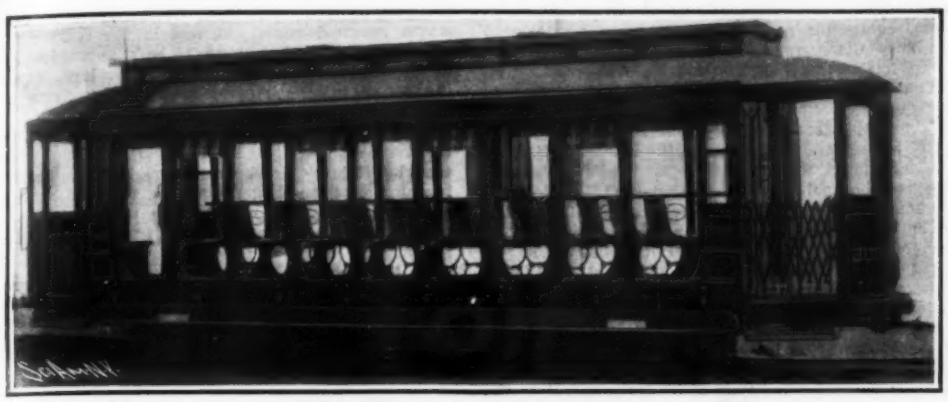
In working the Junior, the operator having closed the chamber and filled it with metal must await the cooling of the cast, and here, in order that the workman may know precisely when to remove it, Mr. Wood assists him with a mechanism which, once set for the time necessary for cooling, will always strike a gong when the specified time has elapsed. Then the operator quickly opens the casting chamber, sets a clutch which starts the cylindrical core, driven by power, to make half a revolution, and the cast is delivered from the chamber, while, during the turning operation, two saws having been brought into play, one separates the cast plate from its riser and the other makes a bevel upon its lower end.

When the cylinder comes to rest, the chamber is again closed and the operator pours his metal for a succeeding cast, but in its closing the back of the chamber thrusts the plate and its riser away from the cylinder, so that, while waiting for the next bell, the operator may remove the plate, drop it into a smoothing device which completes all of the operations necessary for finishing, and may lift off the riser to toss it back into the metal pot.

By means of this simple apparatus, which is semi-automatic but so organized that it requires little intelligence upon the part of those who run it, three plates a minute may easily be produced by two men. Thus it will be seen that Mr. Wood has gone still further in the direction of saving labor in stereotyping, and seems now to have completed the revolution in newspaper stereotyping which he began with the autoplate.

Space does not permit us to describe in detail the ingenious safety system which Mr. Wood has employed to prevent mishaps to its mechanism when handled by unskilled men, but it will suffice to say that the Junior autoplate is substantially "fool-proof," as was evidenced at the convention, when a number of newspaper men endeavored in different ways but without success to put it out of order.

Junior autoplates have been purchased by the Brooklyn Daily Eagle, the New York Evening Post, the Buffalo Evening News, the Boston Traveller, the Boston Daily Globe, the Philadelphia Inquirer, the Philadelphia Bulletin, the Milwaukee Journal, the Minneapolis Journal, and many other papers.

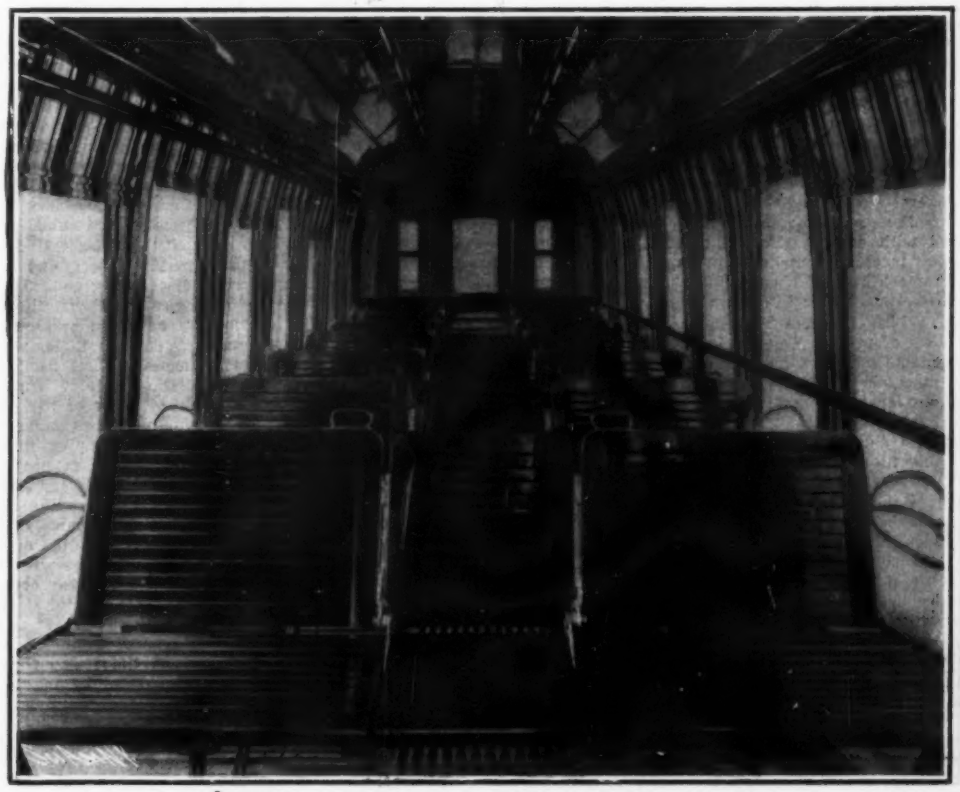


THE NEW CONVERTIBLE CAR.

NEW SEATING ARRANGEMENT FOR STREET CARS.*

By GEORGE J. JONES.

AN innovation in the equipment of street railway cars has been recently turned out by the J. G. Brill Company, of Philadelphia, Pa., which is shown in the accompanying cuts. It was originally designed to meet the exigencies of the service in the Philippine Islands, where the first cars of this character were shipped and are now in operation. The new idea has been found to be such an excellent one that it is probable that cars of this description will soon be seen in the cities of this country. The rolling stock is of the convertible type, and when the sides are closed, as in cold or rainy weather, it is essential that there should be an aisle down the center of the vehicle so that passengers may make their way to and from the seats. In the warm weather, when the sides of these cars are disposed of by raising into pockets in the framework of the roof, the presence of the aisle is unnecessary and it is desirable that it should be given over to the accommodation of passengers. For this purpose a "filler seat" has been designed which is hung in the passageway between the two side seats.



INTERIOR OF CAR WITH AISLE SEATS IN POSITION.

In this manner one full-size seat is presented extending across the entire width of the vehicle. The change is made twice each year, and when not in use the filler seats are stored in the barn.

A feature of the construction of this car for service in the Far East, and one which is not likely to be demanded in this country, is the screen which is to be seen dividing the interior of the vehicle into two compartments. The social conditions existing in the Philippines render this necessary. The dividing partition is of fine wire, which accomplishes the purpose as well as anything else and permits the conductor to have a survey of the interior at all times.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

CONCRETE MIXING MACHINERY.

By WILLIAM L. LARKIN.

THE mixing of concrete by means of machinery is of recent date. The first machine which suggested itself to contractors was the old style "roller and pan" mill used in grinding clay. Robert Hunt, in his "Dictionary of Arts, Manufactures, and Mines," of 1875, speaks of mixing concrete both by hand and by machine. He says that the best mode of mixing is to take burnt limestone with ballast (i. e., gravel) in a dry state and after adding sufficient water turn with shovels and wheel away. He states that in placing concrete in the forms it should be given a fall of some yards to drive the particles closer together and give the whole a greater solidity. In this way he—curiously enough—touches upon one of the principles that are strongly advocated by some makers of concrete-mixing machinery at the present time, that is, a violent mixing of the aggregates and cement. He goes on and says that in some cases it has been found advantageous to mix the ingredients in a "pug" mill, probably meaning the old style of pug mill used in brick-making establishments, in which there were blades intended to mix, and also to break up large lumps of clay. Knight's "American Dictionary" of 1882 speaks of concrete mixing in a pug mill. John Newman, in his "Notes on Concrete" of 1887, speaks of an apparatus at Newhaven, England, capable of automatically measuring, mixing, and delivering 70 yards of mixed concrete per hour. He also speaks of the pan and roller mill like that used for grinding clay, and suggests that a "trough paddle mixer" or "pug mill," preferably such as cost £35, mixes from 8 to 10 yards per hour.

W. M. Patten's "Treatise on Engineering," of 1895, speaks of a "cubical box" and a "trough" mixer as being the most common, as they were at that time.

Since 1875 the making of concrete mixing machinery has had a rapid growth. Contractors soon found that the "Cube" mixer was not convenient enough, and that the "trough" mixer was neither good enough nor durable enough. Like all new fields of effort it was soon overrun, and to-day there are many makers of concrete mixing machinery and many different kinds of machines. The principle on which concrete machinery is built may be outlined briefly here. In the first place, it is desired to turn the material as many times as possible in a given period; secondly, it is most important that the material be thrown from side to side so that the resulting mixture may be perfectly homogeneous. To enlarge upon this point, which is one of the most important ones, imagine for a moment the conditions which actually pertain on a job where the concrete mixer is in use. The stone and sand are thrown into the concrete mixer by means of the most convenient apparatus at hand, either by shoveling it in from the stock pile, dumping it in from a wheelbarrow, or chuting it in from a storage bin. After the concrete and sand have been placed in the body of the mixer it is almost invariably the custom for the attendant or the man operating the mixer to take a bag of cement from a pile near at hand, untie it, tip it upside down and allow the little heap of cement

to drop in the mixer close to one side. Thus while the stone and sand are placed in the body of the mixer more or less evenly spread around, the cement is almost invariably dropped in at one point. Should the mixer not be designed properly the resulting mixture would be very rich in cement on one side of the drum and very poor on the opposite side. As a preventive of this defect means are placed in the mixing drum to cause the material on one side to be thrown clear across to the opposite side, and *vice versa*, so that when the mass is finally mixed it is thoroughly homogeneous and as well mixed in one place as another.

It is beginning to be understood that the more violently the aggregates are thrown together and tumbled about the more thoroughly they are mixed and the better they become coated with cement. It is the object of many makers of modern machinery to violently mix the aggregates and cement by lifting them high and throwing them down again into the mass, and several machines are designed with what are called "coating tables" or stationary plates in the interior of the rotating drum upon which the aggregates are violently thrown, tending to grind the mass together. Another defect to be found in the earlier machines was the tendency of the mass to "ball up" as snow will form into a snowball when rolling down the side of a hill. In fact, the old cubical box type of mixer which particularly has this tendency is used at the present time for making balls of bluing in chemical works. It may be said that the rough usage makes it necessary that concrete machinery be designed in a thoroughly strong and rigid manner, and that all parts subject to wear be made so that they can be renewed easily and so that they will resist abrasion as far as possible. It is well known that cement dust and grit put a very severe strain on gearing, journals, and bearing boxes, and for that reason boxes which support the journals of concrete mixing machinery not only should be dustproof but they should be self-oiling, as it is obvious that the breaking down of a $2 journal box on a concrete mixer might easily cause a loss of as many hundred dollars to the contractor by the stoppage of his work. All wearing surfaces like roller wheels and tracks for the same, should be made of chilled iron of a hard and even texture, and wherever possible should be left unfinished so that the hard scale may remain and leave an excellent wearing surface. Concrete mixing machinery should be of ample capacity to hold the material without spilling or slopping as far as possible. In conclusion, it may be said that the designing of concrete machinery should follow the customs of contractors as regards size. In other words, nearly all cement is sent to contractors in bags which contain about a cubic foot of material. Batches of aggregates and cement to be mixed are usually laid out in what are called 1-bag batches, 2-bag batches, or 3-bag batches; that is, the size of the batch is based on the bag. The 1-bag batch of 1-3-6 concrete consists of 1 bag of cement, that is, 1 cubic foot of cement, 3 cubic feet of sand, and 6 cubic feet of stone; the 2-bag batch consists of 2 bags of cement, i. e., about 2 cubic feet of cement, 6 cubic feet of sand, and 12 cubic feet of stone; and the 3-bag batch consists of 3 bags of cement, i. e., 3 cubic feet of cement, 9 cubic feet of sand, and 18 cubic feet of stone. By adding up the number of cubic feet in each batch it will be seen that the 1-bag batch consists of 10 cubic feet loose aggregates, the 2-bag batch consists of 20 cubic feet of loose aggregates, and the 3-bag batch consists of 30 cubic feet of loose aggregates.

Generally speaking, the proportion of 1-3-6 is that in which the greatest amount of stone is used as compared with cement. For that reason many concrete mixing machinery makers have rated the capacity of their machines as 10-cubic-feet, 20-cubic-feet, and 30-cubic-feet machines; in other words, machines that will hold a 1-bag batch, a 2-bag batch, and a 3-bag batch. In view of present practice this seems to be the most reasonable scheme for rating capacity of concrete mixing machinery.

There are in general use at the present time two great classifications of concrete mixing machinery. The first class includes those known as "batch" mixers, and the second, those that are known as "continuous" mixers. The batch mixer class includes machines such as the cube mixer, the cheese-box style, the tipping mixer, and several others. The continuous class includes mixers such as the paddle trough mixer, one or two rotary cylindrical mixers, and the portable gravity mixer. The distinction between these two classes is as follows: the batch mixer is a machine for which a certain measured quantity of concrete is laid out, introduced into the drum, mixed, and discharged. When this operation is completed the second batch or quantity is measured out and put through the same course. The continuous type of mixer is one in which mixing is always going on. It is continually receiving portions of fresh batches and continually discharging mixed portions of batches previously introduced. In other words, it mixes and discharges constantly without interruption. There are many kinds of concrete mixers at the present time on the market, some of which are popular from long service, some of which may be said to be popular in certain geographical districts, some of which are popular because of some very meritorious feature which tends to make them either labor-saving or more durable for the work.

As said previously, the cubical box mixer is one of the oldest styles of mixer still in use. Generally speaking, it may be said that the cubical box mixer consists of a large hollow cube of sheet steel turning on a horizontal axis through two of its corners. A trap door is placed on one side of the cube at some convenient point and the whole mounted on a high tower with proper means for rotation. This tower is usually built of sufficient height and strength to support a storage bin for the stone, sand, and cement before the same are mixed, and to allow teams, cars, etc., to run under it and receive the mixture when it is discharged. The cubical box mixer is used to-day on many large jobs. This old style cube mixer at the present time is manufactured by all large makers of general contractors' machinery. The United Concrete Machinery Company of New York recently brought out an improvement on the old style cube mixer by making a circular opening at one of the corners through which the axis passes through which the batch may be introduced without stopping the rotation of the mixer. This adds to the value of this type of apparatus in that it saves time while preserving the other good points of the cubical box.

The next style of mixer which came into general use is that known as the cylindrical or cheese-box style, of which the "Ransome," Gilbreth's "Rotary," United Concrete Machinery Company's "Gotham," "American," the "McKelvey," and "National" are examples. This type of machine generally consists of a cylindrical drum with an opening in each head, one for introducing the charge or batch, the other for removing the batch after it is mixed. These mixers generally contain some type of blades attached to the inner surface of the circumference in such a way that they will throw the mass from side to side, lift it up into the air and throw it down, and finally chute it into the discharging means. Some of them depend on the introduction of an iron chute into the discharge hole which catches the falling material on the inside of the drum and discharges it to the exterior by means of its inclined surface. The Gilbreth "Rotary" is a mixer unique in that the opening in each head of the cylinder is large enough so that a wheelbarrow guided by certain fixed iron supports may be introduced entire into the mixer. It is also unique in that it may be charged at the same time at both ends. It was the first apparatus which introduced the feature of stationary coating tables on which the aggregates and cement were violently thrown and mixed and ground together. The United Concrete Machinery Company's "Gotham" seems to be unique in that it is the first rotary concrete mixer on which were placed dust-proof bearings.

One of the most interesting types of concrete mixing machinery is that which is known as the "tipping" style of mixer, of which the Smith mixer, the Municipal Engineering and Contracting Company's mixer, and the United Concrete Machinery Company's "United" mixer are the most prominent examples. These mixers are built with rotating drums mounted on suitable supports, and provided with openings at either end, one for receiving the charge and one through which the charge may be thrown out of the mixer. Their peculiarity lies in the fact that their supporting frames are so arranged that when the charge is entirely mixed the drum is tilted in such a manner that the mixed concrete runs out the discharging end by gravity alone. The Smith mixer takes the shape of a double cone on the inside of which are paddles or small shelves which are arranged to throw the material back and forth. The tipping mixer of the Municipal Engineering and Contracting Company consists of a cube mounted in such a manner that it can be tipped and discharged at circular openings at opposite vertices; it has no blades on the inside. The "United" tipping mixer of the United Concrete Machinery Company combines the good qualities of the cubical box machine with the large capacity of the cylindrical drum machine. Its drum consists of a cylinder on which is formed a pyramidal discharging end. Inside the drum are placed radial blades which lift the material high in the interior of the drum and cast it down again upon a stationary coating table, which tends to grind the material together. The back and forth motion in the inside of the "United" drum is obtained by means of the inclined faces of the pyramidal-shaped end, and by the inclined position of this coating table. While other types of tipping mixers are tilted by hand the "United" mixer is provided with a steam-actuated tilting apparatus of very simple and efficient design, which is a means of saving time. This mixer has another interesting point, namely, that the engine which rotates the drum is mounted on the tilting frame in such a way that it moves with the frame, obviating the necessity of a bevel gear connection between the tipping frame and the usual stationary engine. The engine used on the "United" mixer is known as the square-piston type of engine, is simple in design and so mounted on the frame that it can be directly connected to the drum by means of spur gears. It is so placed that the maximum of energy developed by the engine is actually put into work upon the mass of aggregates and cement, making it possible to get a better and more thorough mix in a shorter time.

Another type of mixer is known as the "Trough" mixer, which is produced by the Jeffrey Manufacturing Company, the Pioneer Iron Works, and many others. This trough style of mixer is one of the oldest types used and had its origin in the pug mill used in clay working plants. It generally consists of a long horizontal trough open at the top through which passes horizontally and longitudinally a heavy steel shaft upon which are mounted a series of iron paddles which take the shape of a screw-propeller of a marine vessel. This long shaft is rotated by power and the batch of concrete shoveled into the mixer, the paddles tending to mix the material and shove it toward the discharging end. The trough is usually placed at a slight inclination to aid the thrust of the paddles in causing the material to run out at the lower end into wheelbarrows or other receptacles placed for it. Another style of concrete mixer which is more or less unique is what is known as "Portable Gravity" concrete mixer, invented some years since by Frank B. Gilbreth, the well-known contractor. Then work was not as plenty perhaps with him as it is at the present time. However, having a piece of work which required mixed concrete in the foundation, it occurred to him that it might be a good idea to set up an inclined chute from the street level down to the bottom of the excavation, in which chute could be placed on end in a vertical position a lot of large spikes or small iron rods. This was done and when the batch on the street level was laid out the laborers shoveled it into this chute or trough in the hope that by the time it reached the bottom it would have been sufficiently tangled up by contact with the pins, etc., in the trough to have received more or less of a mixing. This scheme was found to work very well, and from this crude idea the first portable gravity mixer was developed, which since that time has had a world-wide sale, having been used in the building of fortifications in Japan, Great Docks of Liverpool, public works of South Africa, great battery emplacements of the United States, and innumerable other jobs.

METHOD OF OPERATING CONCRETE MIXERS.

The methods of operating concrete mixers are of course as varied almost as the number of works on which they are used, but the machine is usually placed conveniently to a raised platform on which the batch is laid out, measured, and from which it is shoveled into the drum. In case the apparatus is charged by derrick the same platform is used for the convenience of the man who handles the derrick boxes. The mixer is so placed that the discharge end is sufficiently high to allow the matter to be chuted out into such conveyors as wheelbarrows, tram cars, scale boxes, or dump buckets. It is evident that it is a desirable thing to have a mixer whose charging opening is as low as possible and whose discharging opening is as high as possible, so that the platform may be as near the ground level as possible, and so that the mixer itself may not be unnecessarily raised up above the ground to discharge. The usual method of operation is to place two gangs of measurers and shovelers on the platform, which is built of sufficient size to allow them to work on opposite sides of the charging chute of the mixer. Two other gangs are usually employed with wheelbarrows or other means in bringing stock from the stock pile to the platform. Each gang of measurers and shovelers is provided with a low-sided bottomless box so designed that when it rests on the floor of the platform it will exactly hold the number of cubic feet required by the batch. The necessary amount of stone is dumped into this bottomless box and gauged by a mark on the inside surface, after which the necessary sand is placed over it, and finally the cement spread upon the sand. When this has been done this bottomless box is lifted from the platform, leaving a rectangular heap of aggregates and cement, which is then shoveled into the mixer. Two gangs of men are employed on the platform so that while one batch is being shoveled into the machine another may be measured. This is perhaps the simplest and crudest way of feeding concrete mixers, the next better scheme being that of measuring into scale boxes of sufficient size to hold the required batch, and which are handled by derricks. These scale boxes are dropped near the stock piles and there loaded by the men, four or five gangs usually operating at the same time. As fast as a scale box is loaded it is picked up by the derrick and emptied into the mixer. Another scheme commonly used consists of attaching to the mixer a large iron hopper of the necessary size to hold the batch, in which the aggregates and cement may be loaded while the previous batch is being mixed. After one batch has been discharged the second batch is rapidly introduced into the drum from the hopper by means of a door or gate.

As previously remarked, there are many different styles and types of concrete mixing machines; but in the last twenty-five years a large amount of experience has been gained with the result that the best practice in mixer design has come down to one or two standard shapes and kinds; and it should be the object of prospective purchasers of concrete machinery to avoid what might be called freak mixers, using just discrimination in selecting that machine of standard type which comes nearest to suiting their needs.

On very large jobs where the material is conveyed to the mixer by overhead tram road or by bucket elevators and removed after having been mixed by cars or other means, the cube mixer has considerable favor. The portable gravity mixer in connection with some sort of feeding device is also being used for similar work; and in fact probably the largest piece of concrete construction in the world at present under way is that of the Derwent Valley Water Board, in the Derby Hills, near Sheffield, England. There concrete is being mixed by portable gravity mixers attached to what are known as accurate measurers and feeders. On large jobs where the concrete is handled mostly by derricks, the cheese-box or cylindrical type of batch mixer and the tipping mixer are probably used in 90 per cent of the cases; and this classification of large jobs where the material is handled by the derrick probably covers 90 per cent of works on which concrete is used. The main reason for the use of these

two types is that they are the most convenient to set up and handle and that they may be shifted from one part of the job to another without much trouble. On small contract jobs such as foundations, piers, bridge abutments, etc., it might be said that all kinds of rotary mixers are in general use. For street paving jobs the portable trough or paddle mixer, some types of cylindrical drum continuous mixers, are quite commonly used, for the reason that they are very conveniently mounted on wheels, have low charge and discharge openings and are convenient to operate. Concrete block makers often call for hand power mixing machinery.

FEEDING DEVICES FOR CONCRETE MIXERS.

After concrete mixing machinery had been pretty well developed attention was turned to the question of devices for feeding the aggregates and cement into the mixer. As has previously been explained, these devices first took the form of hoppers attached to the mixer, large platforms from which tip carts could be dumped direct into the apparatus, belt elevators feeding into the storage bins, inclined track hoppers, as exampled by the "International" mixer of the United Concrete Machinery Company, the portable set-up as used in connection with the portable gravity mixer, etc.

MEASURING AND FEEDING DEVICES.

With the increasing use of concrete machinery it became evident, particularly on very large works, that some means of measuring the aggregates to be fed into the concrete mixer were necessary other than that of hand labor, partly on account of the expense, partly on account of the fact that hand work is never as accurate as machine work. As long as cement costs money it will be the desire of cement users to put the right amount of cement in the concrete and no more. It is the engineer's desire that the concrete be absolutely uniform in strength, not being stronger in one place than in another. This defect is quite possible where one man measures the cement for a week and then is substituted by another man who may be less accurate than the previous man. Again, it is pretty certain that in a single day's work the concrete will vary in strength from hour to hour, because of the fact that the gang loading stone and sand into the scale box shovel a little more one time and a little less the next. With the end in view of making concrete more homogeneous, of saving labor, and avoiding inaccuracy, a number of concrete machinery makers have put out what are known as "Measuring and Feeding Devices." Of these devices might be mentioned the "Autometric" mixer, manufactured by the Bonnot Company. It consists of a large cylindrical drum shaped more or less like a short tube mill in which there are the necessary blades for mixing the concrete when the cylinder is rotated. One end of this apparatus rotates in a bin or box with compartments for sand, stone, and cement. On the outside of the drum are peculiar pockets which pick up stone from the stone bin, sand from the sand bin, and cement from the cement bin, and carry them around to a certain point where they automatically slide into the body of the mixer. The Foote mixer is an example of small measuring and feeding device in connection with a concrete mixer suitable for road work and small jobs. The Connolly and Fenn mixers are provided with belt elevators which pick up material from bins placed at a low level. The elevator consists of three parts; one belt carrying a certain number of buckets placed close together which pick up the stone, the second belt carrying one-half as many buckets which pick up the sand, the third belt carrying a variable number of buckets, say one-third as many as there are on the sand conveyer, which serve to pick up the cement. In other words, the proportions are obtained by varying the number of buckets on the belts. These various elevators dump the stone, sand, and cement into a receiving hopper at the top of the apparatus, from which they are led down to the mixer itself, which usually takes the form of a trough mixer.

One of the most successful machines for measuring and feeding is known as the "Gilbreth Accurate Measurer and Feeder," an apparatus particularly suitable for very large jobs. It consists of a tower usually about 30 feet high, 20 feet square, in the top of which is a large storage bin containing three compartments, one for sand, one for stone, and one for cement. Each of these compartments terminates in a small iron chute whose front side is formed by a hinged and weighted gate. The bottom of each chute is formed by the surface of a large drum directly underneath, this drum being supported in the tower in such a manner that it may be rotated under the chutes by means of hand power. The method of operating is as follows: The large storage bins on top are filled by derricks, tramways, elevators, or other means at hand, and the mass in each compartment rests on the drum itself through the chute underneath. These chutes and the drum are so designed that when the latter is stationary none of the material will fall off, but once the drum is rotated the material begins to roll off the drum and pass down through the gates at the front of the chutes. The aggregates and cement as they fall from the drum are caught by what is known as the "concentrating" hopper and are guided into the mixer, preferably the "Portable Gravity" type. It is evident that the amounts of stone, sand, and cement which pass out through the individual gates must necessarily be proportionate to the areas of the openings. By adjusting these gates or openings the desired proportions are obtained and can be maintained without reference to the speed at which the drum is turned. This apparatus has been found very useful on large jobs, and its accuracy is easily within ½ of 1 per cent.

In conclusion, it might not be out of place to suggest to those to whom the subject of concrete machinery is not familiar the methods by which they may recognize a good mixture of concrete when they see it, and the qualifications which a mixer should have. In the first place, good concrete is that which has sand enough to fill all voids in the stone, cement enough to fill all the voids in the sand. It is generally considered that on the mortar, that is, the sand and cement, depends the strength of the final mass. It may be generally said that the amount of mortar should be always in excess of that required to actually fill the voids in the stone. Concrete properly mixed may be known in a number of ways—perhaps the best and easiest test being that of color. Where a mass of concrete shows a variation in color it is pretty certain to be poorly mixed, being reddish in spots, due to the color of the sand, while on the other hand properly-mixed concrete is an even gray color showing that all the stones and grains of sand are perfectly coated with cement.

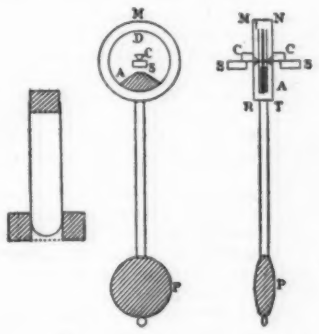
A stony appearance of the resulting mass indicates too little sand. It is very difficult to decide on the proper proportions to use on any particular job until samples of the actual stone and sand to be used are inspected and measured.

The question of the amount of water to be used in the mixing of concrete has been referred to previously in this article, and it may be said that care should be taken that in the handling of concrete too much water is not added so that the cement will be washed away from the stone and sand in places. This is especially true where the resulting mixture is to be used in small quantities, as by the wheelbarrow load.

In conclusion, it may be said that defects in mixing are bad where the mass is used in small quantities, but they are sometimes remedied in handling where the mass is dumped in large quantities from cars or scale boxes into a dam or some large structure, as in such a case the very act of dumping causes the stuff which is not well mixed to become thoroughly mixed and amalgamated with the rest of the mass.

A SIMPLE METHOD OF MEASURING THE DENSITY OF LIQUIDS.

THE only special instruments required for the measurement of the density of a liquid, to the second place



of decimals, are: 1. A small balance (coin balance) sensitive to 5 milligrammes, which may be purchased [in Paris] for 15 francs ($3). 2. An accurately marked double pipette, of 10 cubic centimeters' capacity, which will cost about a franc and a half (30 cents).

In addition there is required a receiver, consisting of a test tube about five inches long, mounted on a cork base, and provided with a cork stopper, as shown in the illustration.

The method of operation is as follows: First, the test tube is thoroughly dried. This may be done quickly and easily by heating it in the flame of a Bunsen burner. When cool, the tube with its cork and base is placed in one pan of the balance, and a counterpoise of about 30 grammes is put in the other pan. Small weights, which must be accurate, are then added to the first pan until the pointer of the balance returns to the zero mark. Calling the sum of these small weights P_1, we have, from the first weighing:

$$\text{Counterpoise} = \text{receiver} + P_1.$$

Next, 10 cubic centimeters of the liquid whose density is desired are drawn into the pipette and transferred to the receiver, which is re-corked and replaced on the scale pan. Calling the weight now required for equilibrium P_2, we have

$$\text{Counterpoise} = \text{receiver} + 10 \text{ c.c. of the liquid} + P_2.$$

The test-tube is then emptied, thoroughly washed, and dried. Ten cubic centimeters of distilled water is placed in it with the aid of the pipette, and it is replaced, corked, on the same scale pan, with weights sufficient to establish equilibrium.

Calling these weights P_3, we have

$$\text{Counterpoise} = \text{receiver} + 10 \text{ cubic centimeters of distilled water} + P_3.$$

Hence,

$$\text{weight of 10 c.c. liquid} = P_1 - P_2$$
$$\text{weight of 10 c.c. water} = P_1 - P_3$$
$$\text{and density of the liquid} = \frac{P_1 - P_2}{P_1 - P_3}$$

At the temperature of my laboratory, 12 deg. C. (54 deg. F.), $P_1 - P_3$ will be found equal to 10 grammes to within 5 milligrammes if the pipette and the small weights are correct. As an example, the density found for bisulphide of carbon by this method is $\frac{12.645}{10} =$ 1.264. The density given by the annual of the Bureau des Longitudes is 1.263.—From the French of E. Sarran in La Science au XXme Siècle.

THE N-RAY PROBLEM.

AN interesting contribution to the N-ray problem, which would seem definitely to solve the question as to the real existence of these rays, is published in the Revue Générale des Sciences of January 30.

Prof. E. Mascart a short time ago asked Prof. Blondlot to repeat in his presence, with special precautions, the experiment of the refraction of N-rays in an aluminium prism. Prof. Blondlot agreed. The refraction spectrum shows a certain number of intensity maxima, which on account of the experimental conditions are so wide as not to admit of the accuracy of optical measurements.

The screen, provided with a thin strip of sulphide previously lighted, was mounted on the carriage of a dividing engine, the figure marked by the index on the ruler being recorded each time the observer stopped the carriage at an intensity maximum. The following figures were obtained by four different observers in the same range:

Blondlot	382.4	....	391.5	398.4
Gutton	....	387.2	393.0	399.0
Virtz	381.0	386.9	392.0	398.2
Mascart	383.4	387.0	391.0	397.0
Average	382.4	387.03	391.9	398.15

In another experiment the dividing engine was so displaced as to have the motion of the carriage occur approximately at right angles to the refracted rays, readings being taken in alternate directions. At each stoppage on a maximum, Prof. Mascart would read the corresponding division of the index without the knowledge of the observer.

Prof. Blondlot thus obtained:

→	387.5	382.3	374.0	368.2	360.2	358.0	353.2
←	386.1	381.2	374.3	368.2	360.2	358.2	353.2
Average	386.8	381.75	374.15	368.2	360.2	358.1	353.2

The Nernst lamp giving off the rays was next extinguished by breaking the circuit, and another set of observations begun on a reduced range to avoid the strain on the observers. The following figures were obtained:

Blondlot	375.6	370.4	363.4	356.2 →
	375.3	370.3	363.4	356.2 ←
Average	375.45	370.35	363.4	356.2
Gutton	"	371.4	364.2	356.1 →
	374.8	367.4	361.3	356.6 ←
Average	374.8	369.4	362.75	356.35
Virtz	374.9	369.8	364.6	357.6 →
	374.6	371.6	364.3	358.2 ←
Average	374.75	370.7	364.45	357.9
Mascart	"	372.0	"	356.0 →
	376.5	371.0	"	356.0 ←
Average	376.5	371.0	"	356.0

In order to give an idea of the accuracy of these experiments, it may be said that in the latter case the deflection was close to 30 deg. and that 1 millimeter of the scale corresponded to about 4 min. The conditions were about the same in the other sets of observations. Prof. Blondlot's pointings were especially accurate, agreeing with each other to less than ½ millimeter, apart from two exceptions, while Prof. Mascart's observations, in view of his lesser skill in this special line of work, obviously admitted of less accuracy.

The above report was recently presented to the French Academy of Sciences, and at the same meeting Prof. C. Gutton communicated the following on the same problem: If N-rays be made to strike the primary spark of a Hertzian oscillator, the secondary spark will be found, according to Blondlot's observations, to decrease in intensity. The action of N-rays is thus shown to alter the electrical phenomenon itself. The action of the primary on the secondary circuit being rendered less energetic by the rays, which reduce the explosive distance, the intensity of the secondary spark will obviously be decreased.

This has been evidenced and photographed by M. Gutton with the aid of brass electrodes. Brass is in fact an alloy sufficiently hard to take a regular shape, while the zinc contained therein imparts to the spark a large number of photographic rays. The length of the spark is taken at 1-30 to 1-40 millimeter, the lighting of the plate being chosen so as just to give an appreciable photographic impression. It may be said that a very slight variation in the intensity of lighting in the neighborhood of critical value will result in a considerable variation in the photographic action.

Prof. Gutton's memoir contains the detailed description of all the experimental conditions. Thirty-seven well agreeing experiments have shown the intensity

of the secondary spark to be distinctly diminished under the action of N-rays. On the plate represented to the Academy, this action was manifested by a very pale spot and a dark spot respectively, differing from each other by about ten times in intensity.

A NEW SOURCE OF INDIA RUBBER.

IN the rubber industry every improvement that promises a larger output is of importance, as the demand is increasing so rapidly, chiefly in consequence of the enormous development of electrical industries, that the supply can no longer keep pace with it. There is also imminent danger of the forests being exploited in so ruthless and destructive a manner, because of the high price of the product, that a "rubber famine" may be produced. The most effective means of combating these dangers, which are by no means imaginary, will be found in better utilization of known rubber plants, especially in the choice of methods which shall injure the plants as little as possible, and in the discovery of other sources of caoutchouc. The ideal rubber plant would be a tree or shrub yielding the valuable material in its fruits. These could be gathered without injury to the plant, which might be protected and cultivated like a pear tree or a grape vine.

The first hope of the realization of this ideal is given by Prof. Warburg in the journal Der Tropenpflanzer. He points out that, while the fruits of the plants now used as sources of rubber contain either no caoutchouc or a quantity so small as not to be worth extracting, the case is different with certain parasitic plants, the caoutchouc mistletoes, which were discovered in Venezuela by Giordana only three years ago. The fruits of these plants contain caoutchouc, not as a milky juice, but in the form of a cohering solid envelope which surrounds the seeds. In some species the caoutchouc amounts to one-fifth of the weight of the dried fruit. The layer of caoutchouc is similar in structure to the layer of "viscia" which surrounds the seeds of the common mistletoe, and is produced by local chemical changes in the cells. There are three groups of species of the Venezuelan caoutchouc mistletoe, distinguished by the size of their fruits. Probably the large fruited species will be found most valuable, because of the facility with which the caoutchouc layer can be removed. The caoutchouc can, however, be obtained by drying the ripe fruit, pounding or grinding it and mixing with water. The unripe fruit yields, by simple pressure, an impure but by no means worthless rubber which can be cheaply transported in the form of cakes.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Umschau.

THE SAN FRANCISCO EARTHQUAKE OF APRIL 18.*

IN the immediate presence of a great catastrophe, in which hundreds of lives have been lost, and San Francisco, the "Queen of the Pacific," has been almost entirely destroyed, it is not to be expected that details of much scientific value should be recorded. All that is here possible is to describe briefly the course of events, to trace in rough outline their connection with former shocks and with the geological history of the district, and to refer to the unfelt earthwaves registered at distant observatories.

NATURE AND EFFECTS OF THE EARTHQUAKE.

Though the coast of California from San Francisco to Los Angeles is one of the chief seismic regions of the globe, the first and greatest shock was heralded by no warning tremors or earth-sounds. It occurred at 5.13 A. M. (that is, 1.13 P. M. Greenwich mean

STRUTANTHUS SYRINGIFOLIUS, A CAOUTCHOUC MISTLETOE.

G, H. Sections of fruit. (Twice the natural size.)

time), perhaps, as the seismographic evidence would imply, a few minutes earlier. As in all tectonic earthquakes of the first magnitude, the duration of the shock was considerable, not less than two or three minutes, and it was in this time that the chief part of the destruction, so far as it was directly due to the earthquake, was accomplished. Five minutes later another and less violent shock was felt, and, in the midst of almost continuous tremors, a third prominent shock took place at 8.15 A. M., and others shortly before 10 A. M., and about 1.30 and 7 P. M. None of these seems to have been registered in European observatories, but they sufficed to throw down walls already damaged. Soon after the first shock, fires broke out in several parts of the city, and spread rapidly, the water-mains having been injured. Attempts, on the whole successful, were made to limit their extension by blowing up passages through the crowded parts, with the result that about one-quarter of the city may be ultimately saved.

Like Charleston, which was so seriously damaged by an earthquake twenty years ago, San Francisco is built upon a peninsula; and the effects of the two shocks, as revealed by the distribution of the damage, were very similar. Although the whole of both cities

PHTHIRUSA THEOBROMAE, A CAOUTCHOUC MISTLETOE.

suffered severely, the chief destruction was confined to houses built on low-lying "made" land. In San Francisco this land is occupied by business houses and warehouses, and, in the southern part, by cheap tenements and poorly-built lodging-houses. At 5 A. M. most persons were in bed, and thus there was little loss of life in the business district, and much in that covered by the tenements. The better-class residential district, situated on the hills, escaped with comparative impunity, so far as the earthquakes were concerned, though the fire afterward spread to that quarter.

That San Francisco was situated within or close to the epicentral area is shown by the continuous aftershocks, and by the effects of the shock. Observers in the open air state that the streets could be seen to bulge and wave as if about to crack open. Three miles of railway have sunk out of sight between Suisan and Benecia; several railway tracks have been destroyed for scores of miles; and on the harbor front the earth appears to have sunk from six to eight inches. Great cracks were formed in the streets, and these cracks were twisted into all shapes. The houses, before they were destroyed by fire, were also seen to be out of alinement.

Outside San Francisco many towns are known to have suffered severely, especially San José, Santa Cruz and Santa Rosa; others less severely, from Mendocino on the north to Monterey on the south. With our present information (and the absence of news from neighboring places, and especially from the Lick Observatory, is disquieting), the meizoseismal area is a band extending along the coast and parallel to the Coast Range, about three hundred miles in length and not more than fifty miles in width. The extent of the disturbed area will remain unknown until inquiries have been made, but it is curious how few details on the subject have been published. Los Angeles (only 350 miles southeast of San Francisco) does not seem to have been affected to any extent by the principal earthquake, though the shock was felt severely throughout the whole of the neighboring State of Nevada, and there are vague reports of more distant observations.

POSITION OF THE EPICENTER AND SEISMIC SEA-WAVES.

If the line drawn so as to bound the known area of destruction be even approximately correct, there can be no doubt that the epicenter was submarine and situated some little distance from the coast. The fact that the shock was felt at San Francisco two or three minutes after the epicentral time implied by the seismic records is also in favor of this conclusion. The chief difficulty in accepting it lies in the absence of any very great sea-waves. Much of San Francisco is only about twelve feet above high-water mark, and would have been submerged by any considerable wave. There seems, however, to have been some disturbance of the sea. Many vessels, it is said, were washed ashore with each disturbance, and washed out again by the receding waters. There are also unconfirmed reports that Terminal Island, a seaside resort about twenty miles from San Francisco, has been destroyed by a sea-wave, and that other places on the Californian coast have also been swept away. At present it is probable that the first decisive evidence of sea-waves, if any existed, will come to us from the eastern shores of Japan, which would be reached by them in about ten and a half hours after the earthquake.

GEOLOGICAL RELATIONS OF THE EARTHQUAKE.

The earthquakes of California have been studied for some years by Messrs. Holden and Perrine, of the Lick Observatory, and the geology of the State is being revealed through the labors of Messrs. Russell, Diller and Lawson; while an admirable summary of their relations was recently presented by M. de Montessus' valuable work on "Géographie séismologique" (pp. 404-412). Between the Rocky Mountains and the Pacific are the parallel chains of the Sierra Nevada and the Coast Range. Among the Rocky Mountains earthquakes are few and slight; on the eastern slopes of the Sierra Nevada they are more frequent, and sometimes, as in the Owen's Valley earthquake of 1872, of considerable severity. The western portion of the Sierra Nevada, the Cascade Range, is remarkably free from earthquakes, though it is worth noting by those who see an intimate relation between volcanic and seismic actions that it contains the recently extinct cones of Shasta, Mount Hood and Mount Rainier. Again, the Coast Range, and especially the districts surrounding San Francisco and Los Angeles, is one of the great seismic regions of the globe. Lastly, to the west of California the sea-bed deepens rapidly, the contour of 4,000 meters lying only a short distance from the land, and from this region many of the strong California earthquakes are known to proceed.

Recent studies have established a close connection between these earthquakes and the geological structure of the district. Whether the earthquakes take place under the Coast Range or beneath the adjoining ocean, the longer axes of the isoseismal lines are either parallel or perpendicular to the suboceanic contour-lines, the crust-folds of the Coast Range and the long lines of fault of the Pacific seaboard. It is difficult to resist the conclusion that in the western United States we are presented with mountains in four successive stages of growth. In the Rockies we have ranges so ancient that they have almost ceased to grow; in the Sierra Nevada to the west another which is approaching old age; the Coast Ranges are in the stage of youthful, vigorous growth, with the possibility of a long and active life before them; while, still farther to the west and not yet risen above the ocean, there seems to lie an embryonic range, of which the San Francisco and other earthquakes are the birth-throes.

THE UNFELT EARTH-WAVES.

In all parts of the world delicate seismographs soon afterward recorded the occurrence of a violent earthquake. The first waves reached Victoria (B. C.) at 1.15 P. M.; at Washington the movement was so strong that the pen passed off the recording sheet. In a quarter of an hour the seismographs of Great Britain took up the tale, large disturbances being recorded at Shide, Hidston, and Edinburgh; at Birmingham the pointer of the Omori horizontal pendulum swept three times off the drum. Passing over to the Continent, they set to work the instruments at Berlin, Heidelberg, Vienna, Laibach, Turin, Rome, and many other places. The pendulums at Florence shared the fate of those at Washington and Birmingham. The seismograph at Cape Town also registered the movement, while those in Japan were disturbed by the waves proceeding in the opposite direction across the Pacific. Only the scantiest details are as yet made known, but, if we may judge from the diagram at Birmingham, the complete series of records will be one of great interest and value.

The first series of preliminary tremors reached Birmingham at 1h. 25m. 3s. P. M. (G. M. T.). They were small in amplitude and had an average period of 6.4 seconds. At 1h. 35m. 7s. they were followed by the

PHTHIRUSA THEOBROMAE, A CAOUTCHOUC MISTLETOE.

G. Section of fruit. (Twice the natural size.)

second series of preliminary tremors, much larger in amplitude and with an average period of 11.4 seconds. These tremors, as is now well known, traverse the body of the earth with velocities of about 10 or 11 and 5 kilometers per second respectively. At 1h. 45m. 13s. began the principal portion of the movement, consisting of undulations which travel over the surface with a nearly uniform velocity of 3.3 or 3.4 kilometers per second. In the initial phase of this portion the undulations had an average period of 44.1 seconds; in the slow-period phase (which began at 1h. 50m. 22s.) of 25.2 seconds, and in the succeeding quick-period phase of 16.2 seconds. Unfortunately, this portion of the record is incomplete, for the pointer of the pendulum

* Nature.

swept off and on the drum three times, several waves being thus lost, and the initial epoch of the quick-period phase cannot be determined. The end-portion of the disturbance began at 2h. 1m. 4s., and consisted of a long series of unusually clear and regular waves with an average period of 15.0 seconds. The duration of this portion is uncertain, for these waves were reinforced at 3h. 28m. 38s. by the undulations of the principal portion which traveled through the antipodes along the major arc joining San Francisco and Birmingham. At 3h. 56m. 57s., however, the trace becomes nearly steady, but a careful examination reveals another series of long, low undulations from 4h. 58m. 32s. to 5h. 6m. 34s., which represent the return of the first series of surface-undulations after they had completed the tour of the globe and traveled once more as far as Birmingham. The interval between the first and third passages of these waves is 3h. 13m. 19s., and corresponds to a mean velocity of 3.36 kilometers per second.

MAGNITUDE OF THE SAN FRANCISCO EARTHQUAKE.

The mere fact that the earth-waves should disturb a seismograph after traveling 30,000 miles is sufficient evidence to show that the earthquake belongs to the very front rank. If we might estimate the intensity of a shock by the maximum range of movement at Birmingham, we should have to regard the San Francisco earthquake as much stronger than the Indian earthquake of April 4, 1905, but as inferior to the remarkable Central Asian earthquakes of July 9 and 23, 1905. The period of the larger waves approaches, however, so closely to that of the pendulums themselves that it by no means follows that the range and epoch of the maximum displacement of the instruments correspond with those of the earth's crust. Nor can we infer much from the extent of the destruction of the lofty, badly-founded houses of San Francisco. If the Colchester earthquake of 1884 had originated between the city and west-end of London instead of beneath the villages of Peldon and Rowhedge in Essex, the damage would have been considerable, and the earthquake would have held a higher place in our estimation. When, however, we consider the great area covered by the injured towns in California, the displacement of the superficial soil, the crumpling of the railway tracks, and the widespread registration of the unfelt waves, it is clear that we must give to the San Francisco earthquake a place inferior, no doubt, to the Lisbon earthquake of 1755 and the Indian earthquake of 1897, but probably one in the same rank as the Neapolitan earthquake of 1857, the Japanese earthquake of 1891, and the Indian earthquake of 1905. C. DAVISON.

RECENT ADVANCES IN FINE MEASUREMENT.*

THE limit of fineness of mechanical measurement at present attainable with absolute certainty, by the use of the most accurate micrometer microscopes or thickness measurers, fundamentally dependent on the accurate cutting of excessively fine screws, is the thousandth part of a millimeter or the twenty-five-thousandth part of an inch. The celebrated mechanical measuring machine of the late Sir Joseph Whitworth, dependent on a fine screw and on the delicacy of the sense of touch, reads directly to the ten-thousandth part of an inch. Sir Joseph Whitworth did, indeed, succeed in constructing a mechanical measurer, for the accurate determination of the length of the standard yard, which read to a millionth of an inch. But grave errors rapidly develop in such machines with the wear of the several screws employed, and a grain of dust is fatal to the trustworthiness of the sense of touch beyond the limit of the ordinary Whitworth machine just referred to. Hence, the twenty-five-thousandth of an inch may be taken as the limit of measurement of mechanical measurers of general application.

But we possess a physical means of measurement three hundred times more refined than this and free from the difficulties alluded to; that is, one which enables us to determine variations in length, thickness, or position with absolute accuracy to the eight-millionth part of an inch, or one three-hundred-thousandth of a millimeter. The foundation of this truly wonderful scale is the wave-length of light, a quantity which is now known with great accuracy for the most important lines of the spectrum.

Moreover, the method is rendered æsthetically beautiful by the fact that an actually visible scale can be produced, composed of black interference bands on a brilliant background of pure monochromatic light. Further, the interval between any two bands can be subdivided into one hundred parts by employing a micrometer eyepiece on the observing telescope.

To produce the bands the monochromatic light requires to be reflected from two surfaces, almost, but not quite, in contact, one of which must be of transparent material. They must be arranged so that the intervening film of air is slightly wedge-shaped instead of being of uniform thickness, the amount of tilt of one surface with respect to the other determining the width of the bands. The value of such a scale for measuring purposes will be at once apparent when it is pointed out that if one of the reflecting surfaces approaches to or recedes from the other the interference bands also move, at right angles to their length, and that the passage of any two consecutive bands over a reference mark corresponds to a movement of the surface referred to equal to half the wave-length of the light employed. Hence, it only remains to count the number of interference bands which pass the reference mark, and to use the micrometer to determine any initial and final fractions of a band, in order to obtain the measure of the amount of motion of the surface.

This principle was first applied by Fizeau for the determination of the expansion by heat of solid substances. It has the inestimable advantage, in the case of costly or rare substances, of only requiring a small quantity of the material under investigation, a cube of one centimeter edge being ample. The principle was subsequently extended by Koch to the determination of the elasticity of thin plates.

* Dr. A. E. H. Hutton in Times Engineering Supplement.

CHESS PLAYERS' TIME-KEEPER.

IN the noble game of chess it is customary to count the time which each of the players takes for his move and at the end of the game to add all the periods together. Chess, of all games, requires most mental power and activity for making combinations. In each of his moves the player must foresee the steps his adversary is likely to make. This is an enormous labor of the mind, and it is of moment whether a player takes a few seconds only for estimating the combinations, while another employs a quarter of an hour.

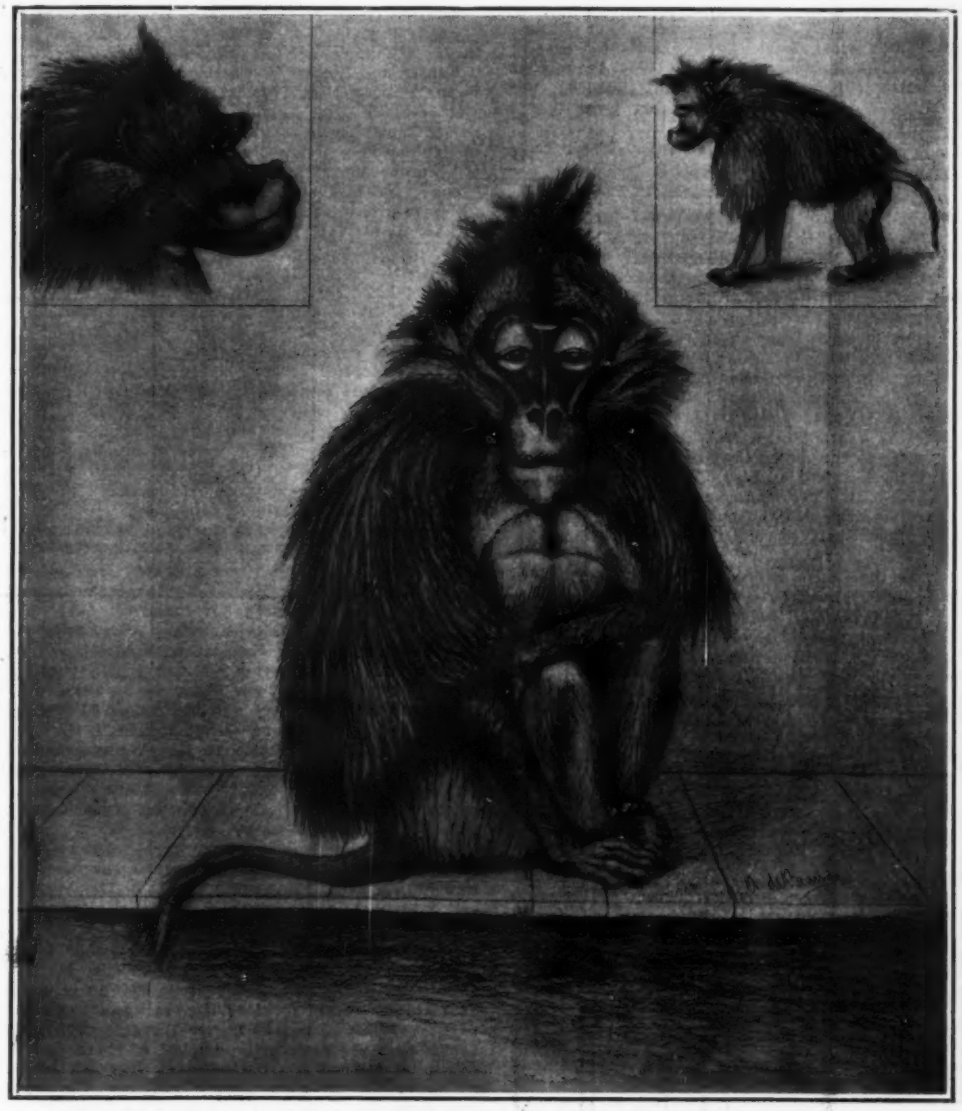
In order that the players of less skill or experience shall not endeavor to equalize the chances by consuming a longer time for reflection, a certain maximum time is accorded for a given number of moves. For example, the space of an hour may be allowed for fifteen moves and this total time must not be exceeded. The need of a special time-piece for governing this result is apparent, and we have several times received inquiries relative to apparatus for this purpose. A small clock designed especially for chess players has been designed by Herr Veenhoff of Groningen.

This apparatus is composed of two similar small clocks, mounted side by side on a wooden platform. Behind the clocks a mechanism is installed, designed to be set in action and to stop according to the movements of the players. It consists of a long double lever, pivoting at the middle on a support fixed to the platform, and is furnished with a button at each of its extremities. The two arms of this lever, which can oscillate like the beams of a balance, each move within a kind of fork serving as a guide. They are each provided with a long and flexible brass rod, which passing through a slit made in the back of the respective clocks, projects into the movement. These two rods are placed in such a way that when the double lever is horizontal, they lightly touch the balances and stop them.

When pressure is applied on one of the buttons of the lever, the corresponding balance is disengaged, while the other continues locked until the other extremity of the lever is depressed. The operation is, therefore, as follows: The two clocks when wound are both set at, say, the twelve hour mark, and the lever adjusted horizontally. When the first player, A, commences, his antagonist, B, presses on the button next to him, and thus sets one of the clocks, that of A, going. The latter, having played, in his turn presses on the other button, and by so doing stops his clock and sets that of B going, which will continue to work until B has played; and so on. At the end of the game the clocks will indicate exactly the time employed by the respective players for the total of their moves.—Translated from the Deutsche Uhrmacher Zeitung.

THE GELADA OF THE ZOOLOGICAL GARDEN OF LEIPSIC.

THE Leipsic zoological garden has recently acquired the fine adult male gelada (*Cynocephalus gelada*) shown in the accompanying illustration. These singular baboons are found, living in small flocks in the mountains of Abyssinia, at an elevation of 10,000 feet above the sea. In appearance the gelada is one of the most grotesque of baboons. The bony arch of the eyebrow is enormously developed and the cheek and jaw bones form very sharp ridges which extend from the eyes to the nostrils. The muzzle is much larger and the nostrils more retracted than in any other of the cynocephali. A coat of extremely dense and long hair covers the trunk from the head to the root of the tail.



THE GELADA OF THE ZOOLOGICAL GARDEN OF LEIPSIC.

The gelada is particularly characterized by two hairless bright red prominences on the chest, a bare strip of the same color surrounding the throat like a necklace, and bright red eyelids. When aroused to anger the animal raises his upper eyelids so high that his eyes appear surrounded by large patches of red, and turns his long lips, the inner surface of which is also bright red, completely inside out, so that the upper lip covers the nose and the lower lip covers the chin, exposing the long and sharp canine teeth, which resemble those of the carnivora. At the same time he tosses up his head and displays the hairless red spots. The long hair of the mantle is black, the short fur of the hind legs light brown and that of the breast light gray. The voice of the gelada is exceedingly rich in modulations and is usually soft, but even its loud cries are less harsh and strident than those of the mandril. Its food consists of leaves, roots, seeds, and insects. The gelada of the Leipsic zoological garden eats hay and grain and is particularly fond of lettuce.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Die Illustrirte Zeitung.

Correspondence.

GREEK ASTRONOMY.

To the Editor of SCIENTIFIC AMERICAN SUPPLEMENT:

Many astronomical books continue utterly to ignore the ancient Greeks' work, and this is not right.

In your number of February 17, 1906, there is an erroneous history of "The Sun's Distance," which says in part: "The first determination we have any record of is that made by Hipparchus more than two thousand years ago. . . . He concluded that the distance of the sun was 650 times greater than the earth's diameter; . . . a value 18 times too small. The wonder is, not that Hipparchus was so far wrong, but that his genius enabled him to come to any conclusion at all. . . . . For eighteen centuries this value of the sun's distance remained uncorrected. . . . The mean value of the sun's distance is 92,900,000 miles."

In Plutarch's Chaeronensis, Moralia, De placitis philosophorum, Lib. II., § Δ A, we find that according to Eratosthenes the sun's distance equals 804,000,000 stadia. Now each stadium is equal to 185.184 meters, 804,000,000 × 185.184 = kilometers 148,887,936 = 92,514,496 miles. Thus Eratosthenes (276-194 B. C.) knew as much about the sun's distance as our modern astronomers, and this ought not to be ignored, at least by astronomers.

Hipparchus was a century younger than Eratosthenes. The ancient Greeks knew exactly (as exactly as ourselves) the nature of the Milky Way, the motion of the earth (fifteen centuries before Galileo), the habitability of planets, and many other great things according to Plutarchus.

L. CALAMIDAS, Engineer.

Constantinople, Turkey, March 21, 1906.

RELATIVE TOTAL HEAT RECEIVED FROM SUN AND SKY DURING ANY DAY BY HORIZONTAL SURFACES.*

AN accurate way of considering the amount of insolation at any locality is to compute the total radiation (expressed by its equivalent heat in calories) received by a horizontal surface in the natural daytime of that day and latitude, taking account of the absorption by the atmosphere. (See Annales Agronomique, 1878, IV, pp. 270-296, or Ann. Report Chief Signal Officer for 1881, pp. 1200-1216.) This has been done by Aymonnet by a graphic method. He assumes that if the sun were in the zenith then the unit of horizontal earth's surface would, because of atmospheric absorption, receive only 0.75 of the heat that it would receive if it were outside the atmosphere. Of the remaining 25 per cent one-half reaches this horizontal unit by way of the diffuse reflection from the sky, so that with the sun in the zenith the unit receives 0.875 of the original solar heat. For a point on the equator during twelve hours this would amount to 0.875 × 12 × 60 × 60 of the total possible if the sun were in the zenith. Using this as a basal datum, Aymonnet obtains the relative numbers given in the following table or the ratio of the heat actually received during one day to that which would have been received if the sun had stood for twelve hours in the zenith. Thus on June 20, at latitude 30 deg., the horizontal unit receives 0.347 of that corresponding to the ideal sun in the zenith all day, while at the north pole on the same day the horizontal unit received during twenty-four hours 0.328 of what it would had the sun stood in the zenith for twelve hours. In fact the amount of heat received by horizontal surfaces is nearly uniform for all latitudes for the days June 15 to July 28. These relative numbers or ratios may be turned into absolute calories by multiplying them by the so-called "solar constant," whose value is probably between two and three calories per minute per square centimeter.

Relative quantities of total heat received on specified days from the sun ar sky at different latitudes by a unit surface of horizontal ground during one cloudless day, allowing for the absorption and diffuse reflection of ordinary clear air, as computed by Aymonnet.

Dates, 1874.	Declination of Sun, North.	Latitude.						
		0°.	10°.	30°.	50°.	70°.	80°.	90°.
March 20	0 07	0.301	0.295	0.255	0.175	0.075	0.029	0.000
March 28	3 09	0.298	0.297	0.268	0.190	0 098	0.049	0.017
April 7	6 52	0.295	0.303	0.284	0.215	0.127	0.082	0.058
April 15	9 48	0.292	0.306	0.296	0.235	0.157	0 115	0.100
April 25	13 14	0 288	0.307	0.310	0.261	0.191	0.159	0.161
May 5	16 17	0.284	0.305	0.322	0.281	0.226	0.207	0 205
May 15	18 54	0.279	0.304	0.331	0.298	0.255	0.249	0.260
May 25	20 56	0.274	0.304	0.337	0.313	0.282	0.280	0.286
June 5	22 34	0.272	0.303	0.342	0.324	0.304	0.312	0.318
June 15	23 20	0 268	0.302	0.346	0.329	0.314	0.323	0.326
June 19 to 20	23 27	0.267	0.301	0.347	0.330	0.315	0.325	0.328
July 7	22 36	0.272	0.303	0.342	0.324	0.304	0.312	0.314
July 19	20 51	0.274	0.304	0.337	0.313	0.282	0.279	0.284
July 28	18 50	0.279	0.304	0.331	0.298	0.255	0 249	0.261
August 7	16 25	0.284	0.305	0.322	0.281	0.226	0.209	0.207
August 18	13 06	0.288	0 307	0.310	0.261	0.191	0.159	0.162
August 26	10 45	0.290	0.307	0.301	0.248	0.164	0.128	0.115
September 5	6 48	0.295	0.308	0.284	0.215	0.127	0.082	0.058
September 15	3 00	0.298	0.297	0.268	0.190	0.098	0.049	0.017
September 23	0 06	0.301	0.295	0.255	0.175	0.075	0.029	0.000

RELATIVE TOTAL HEAT RECEIVED DURING CERTAIN MONTHS.

By adding the amount for each day of any month in the following table we get the relative numbers for the total amount of heat received direct from the sun at various latitudes during certain months by a unit of horizontal surface under a clear sky, and after absorption by ordinary clear air, plus the amount received from the diffuse sky light or the atmospheric reflection, all expressed in terms of the amount that unit surface would receive if the sun were constantly in the zenith during twelve hours. The coefficient of transmission through one atmosphere for zenithal sun is, as before, 0.75, and the added sky light is 0.125, to accord with the Arago-Davy conjugate thermometers, since these are affected by the sum of the heat received by their surfaces from the sun and from the atmospheric particles in the visible celestial vault.

Relative quantities of total heat received monthly at different latitudes in the northern hemisphere.

Month.	0°.	10°.	30°.	50°.	70°.	80°.	90°.
March 20 to 31	3.7	3.7	3.3	2.3	1.1	0.6	0.2
April	10 0	10.6	10.1	8.0	5.4	3.9	3.4
May	9.8	10.7	11.7	10.5	9.0	8.6	8.7
June	9.2	10.4	11.0	11.3	10.7	11.0	11.1
July	9.7	10.7	12.1	11.3	10.3	10.1	1.02
August	10.1	10.7	10.9	9 2	6.8	5.9	5.8
September 1 to 23	7.7	7.8	7.1	5.2	2.7	1.5	0.9
Total	60.2	64.6	67.1	57.8	46.0	41.6	40.3

* Abstract from Cleveland Abbe's "First Report on the Relations Between Climates and Crops."

PHOTO-CHEMICAL INTENSITY OF SUNSHINE.

Bunsen and Roscoe, in a series of memoirs published in the Philosophical Transactions, London, 1857, 1859, and 1863, entitled, "Photo-chemical Researches," discussed the methods of measuring the chemical action of light by help of photographic tints, and endeavored to improve upon the methods of Herschel, Jordan, Claudet, and Hankel. They adopted as a standard unit for measurement that intensity of the light which in one second of time produces the standard tint of blackness upon the standard paper. Their methods are too laborious for the ordinary meteorological observer, but have furnished some important data as to the chemical activity of diffuse sunlight and of total daylight.

In his memoir of 1864, Roscoe states that he and Bunsen had developed a method of determining the chemical intensity of both direct sunlight and diffuse sunlight, or the total daylight, that is, based upon the law that the intensity of the light multiplied by the duration of exposure of chloride of silver paper of uniform sensitiveness gives a series of numbers proportional to the shades of tints, so that light of the intensity 50, acting during time t, produces the same blackening effect as light of intensity t acting during the time 50. According to this method the chemical action of the total daylight was determined for Manchester, England, many times a day during 1864, and the total daily chemical intensity has been computed for the year August, 1863, to September, 1864. Very large changes in chemical intensity occur when the sky is cloudless and unchanged as far as the eye can perceive. The total intensity for an apparently cloudless day varies from 3.3 for December 21, 1863, to 119, June 22, 1864. This last number, compared with the figure 50.9 for June 20, and 26.6 for June 28, shows the enormous variations that take place in the chemical rays that reach the observer at Manchester on cloudless days. This variation is undoubtedly due in part to smoke and moisture, but possibly other unknown influences are also at work.

In 1867 H. E. Roscoe communicated to the Royal Society the results of work done by his method at Kew, England, in 1865, 1866, and 1867; at Heidelberg, 1862 and 1863, and at Para, Brazil, 1866. The general results are that the chemical intensity attains its maximum at noon and not, like the temperature, at some time after noon. Everywhere the intensity increases from hour to hour with the altitude of the sun, and is very closely proportional to it even when the sky is partially clouded, but of course the rate of increase varies with the season, the amount of cloud, and the degree of atmospheric opalescence. The total chemical intensity for each month, as determined from numerous observations, is as follows for Kew:

Total photo-chemical intensity of direct and diffuse light (Roscoe).

Month.	1865.	1866.	1867.	Month.	1865.	1866.	1867.
January	.....	15	13	July	114	107	.....
February	.....	24	22	August	89	94	.....
March	.....	34	31	September	108	70	.....
April	98	52	.....	October	23	29	.....
May	118	79	.....	November	18	16	.....
June	82	92	.....	December	(8)	(14)	.....

Roscoe compares these figures with the cloudiness and finds that the ratio between cloudiness, expressed on a scale of 10, and the chemical intensity is as 1 to 5 in some months and as 1 to ½ in others. A similar irregularity of ratio is found when he considers the absolute moisture in the atmosphere; whence he concludes that the variations in chemical intensity, as between the spring and autumn, are not perfectly explained by either of these factors. He finds the high autumnal and low vernal intensity fairly well explained as due to the transparency or opalescence produced by finely divided solid particles or dust.

Passing from Kew to Para, it appears that the chemical action of total daylight during the month of April, 1866, at Para was 6.6 times as great as at Kew.

In order to obtain data for a clearer atmosphere, Roscoe and Thorpe conducted observations in 1867 near Lisbon, Portugal, and published their results in a memoir of 1870, where they have given the relation between the sun's altitude and the chemical intensity. The intensity is the same for hours that are equidistant from apparent noon. The relative intensity of direct sunlight, reflected sky light, and total insolation is shown for different altitudes at Lisbon by the following table:

Intensity of insolation at Lisbon for clear skies.

Mean Altitude of Sun.	Number of Observations	Observed Chemical Intensity.		
		Sun.	Sky.	Total.
9.85°	15	0.000	0 038	0.038
19.68°	18	0.047	0.062	0 085
31.23°	22	0 052	0.100	0.152
42.22°	22	0.100	0.115	0.215
53.15°	19	0.136	0.126	0.262
61.13°	24	0.195	0.132	0.327
64.23°	11	0.221	0.138	0.359

In general, the total intensity is directly proportional to the number of degrees of altitude. For altitudes between 18 deg. and 35 deg. the intensity on a plane perpendicular to the incident rays is about the same as the intensity of total sky light on a horizontal plane. The intensity of direct sunlight on a horizontal plane is equal to the intensity of total sky light on a horizontal plane when the sun's altitude is about 45 deg. At all altitudes of the sun below 21 deg. the chemical action of diffuse daylight exceeds that of direct sunlight.

In their memoir of 1871 Roscoe and Thorpe determined the amount of chemical action for total sky light of a cloudy sky during totality of the solar eclipse, and found it much less than 0.003, and therefore not measurable. They found the total chemical action of the direct sunlight to be strictly proportional to the visible area of the portion of the solar disk up to a certain point in the obscuration, after which the influence of sky light is inappreciable. For altitudes below 50 deg. at Catania, Sicily, as elsewhere, the amount of chemical action effected by diffuse daylight on a horizontal surface is greater than that exerted by the direct sunlight. At altitudes less than 10 deg. direct sunlight is almost completely robbed of its chemically active rays.

IMITATION OF PRECIOUS STONES.

UNDER the name of imitation stones four classes of essentially different products may be distinguished. The first includes fine stones, imitated by other stones, but of inferior value. In the second class are stones imitated by different species of quartz. The third category is that of imitation by means of ordinary or of special glass, to which has been given the name "strass." Finally, the fourth class of false or imitation stones is that of veneered stones or doublets.

The stones of the first class are substitutions rather than imitations. The connoisseur will not readily be deceived by imitation of quartz, of strass, or by a veneered stone (doublet) but perhaps he may be led to purchase as a diamond a stone of inferior quality.

It is in reality the diamond which is the object of substitution. For this purpose sapphires or topazes, more or less uncolored, may be made use of; these with reference to their composition differ but little from the diamond. The colorless topaz of Brazil, denominated the *goutte d'eau* ("tear") by lapidaries, has when cut and polished the appearance of a diamond. These topazes always find purchasers at a comparatively high price, for the purchaser often entertains a secret hope of reselling them as diamonds.

Numerous substitutions of this kind occurred in Paris about 1865, and gave rise to a famous lawsuit. The Académie des Sciences recognized the stones sold as diamonds by numerous jewelers to be Brazil topazes, and a seller was tried and convicted. If the deceived jewelers had been better informed, they would have had no trouble, for these stones can be scratched by the genuine diamond. Impostors are not hindered by the tint which a topaz may have, as it has been long known that the color can be removed.

The sapphire is also well adapted to substitution. It is next to the diamond the most highly-esteemed precious stone. The most beautiful sapphires come from the East Indies. The white sapphire is as rare, and almost as brilliant as the diamond. The finest sapphire may itself be imitated by the blue tourmaline or Brazil sapphire, as may also the ruby by the rose tourmaline or ruby of the Orient. Another Brazilian, the cymophane, when it is transparent, imitates the yellow diamond.

Almost all fine stones may be imitated with different kinds of quartz. And these imitations sometimes deceive even an experienced buyer, for the result of the examination with the file is the same as for a genuine diamond.

Quartz has for a base one of the common substances in nature, silicon. This substance occurs in the most varied forms and aspects; different names have been given to it when assuming well-known substances, of which at first the same origin is not recognized. The variety of quartz known as rock crystal or hyaline quartz is that which arouses the greatest interest of the jeweler. The most beautiful rock crystal comes from Madagascar, but it is found in numerous other countries, and especially in countries having granitic mountains or similar rocks. The ancients regarded

quartz as congealed water. The experiments of modern chemists have shown that it is hydrated silica (silex). Stones of quartz, which in reality are fine stones but of secondary order, are not to be confounded with the diamond, the white sapphire, or the "tear" topaz. The diamond is harder, weighs more, and has an adamantine brilliancy peculiar to itself. The white sapphire is also harder and weighs more. It has a luster less brilliant and retains for several hours the electricity that has been developed by friction; the same is the case with the colorless topaz. Rock crystal was worked in ancient Athens with rare perfection. Jewelry and other objects of luxury were manufactured from it. The inhabitants of India and China knew also the art of cutting and working quartz. Stones of the third category are manufactured; that is to say, the material from which they are formed is not a natural product, but a composition, which, if the purity and homogeneity necessary for rivaling the genuine diamond are desired, must be worked with the greatest care. The special glass resulting from the composition is generally designated under the name *strass*.

The formula giving the best results is the following: rock crystal, 32 parts; minium, 50 parts; potash, 17 parts; borax, 1 part; arsenic, ½ part. These products should be carefully weighed, pulverized, and mixed, and then put in an oven the temperature of which should be regularly maintained. The mass should be allowed to cool slowly, while remaining perfectly still. The uncolored strass is thus secured ready for cutting. For imitating colored stones, the glass is prepared by adding to the composition metallic salts, such as gold chloride, cupric oxide, and cobalt oxide.

Thirty years ago the jewelry trade witnessed the appearance of a new product, denominated "artificial diamonds." These were stones of strass, or even of ordinary glass, cut like veritable diamonds, the pavilion of which was covered with a thin layer of silver, which gives to the facets great refracting power. This coating of silver is deposited by dipping the stone in special baths, and as it is exceedingly thin, it is reinforced by the galvanic method, or protected by means of a special varnish.

Veneered stones (doublets), which form the fourth category, are, as their name indicates, objects the upper part of which may be either genuine stone or a piece of colored quartz, while the lower part is glass. The two pieces are united, either by cementing, or by placing them in a setting so arranged that the line of junction is completely concealed. The principal part of the stone may also be of rock crystal—that is, colorless—with a pavilion of colored glass. Thus are obtained artificial rubies, sapphires, emeralds, and other stones, which, when mounted, have the color and apparent hardness of genuine stones. Another class of veneered stones consists of two uncolored pieces, one of quartz, the other of glass, between which is interposed a layer of transparent cement, colored according to the stone to be imitated. At the commencement of the last century the veneering of stones was introduced on a considerable scale, and the first artists in that line succeeded in deceiving many buyers.—Almanach de l'Horlogerie et de la Bijouterie.

CONTEMPORARY ELECTRICAL SCIENCE.*

DEFORMATION OF MOVING ELECTRONS.—According to the hypothesis of Lorentz, the axis of the electron which lies in its direction of motion is shortened in the ratio $1 : \sqrt{s}$, where $s = 1 - u^2/v^2$. This shortening extends to all matter, and accounts for the negative result of the Michelson-Morley interference experiment. Now A. H. Bucherer announces that Kaufmann's latest results as to the longitudinal mass of Becquerel rays do not agree with Lorentz's deformation, but they agree with the theory of incompressible electron as well as with a rigid electron. The author's incompressible electron is shortened in the direction of motion and expanded in all directions normal to the direction of motion, thus becoming a Heaviside ellipsoid with one axis of length $a^3\sqrt{s}$ and two axes of lengths $a/^6\sqrt{s}$. This also accounts for the Michelson-Morley experiment, but it has distinct advantages over the Lorentzian deformation. It is not necessary to assume new and unknown forces within the electron, and the energy of the internal forces remains constant. The new electron has no tendency to turn its longest axis into the direction of motion, and the work of the external forces equals the increase of energy of the field.—A. H. Bucherer, Physikalische Zeitschrift Dec. 1, 1905.

SMALL SPARK LENGTHS.—G. M. Hobbs has studied the behavior of very small spark-gaps in order to explain the results obtained by Earhart and Carr, and to find whether Paschen's law of the constancy of the product of maximum gas pressure and sparking distance for a given P.D. applies to these small gaps. He finds that with gaps ranging from zero to 0.003 millimeter (3μ) the discharge is wholly independent of the gas between the electrodes. It simply depends upon the nature of the metal, and the heavy metallic ions convey the whole discharge or a considerable portion of it. Platinum requires a comparatively high voltage and aluminium a much lower voltage, the intermediate metals being antimony, silver, nickel, magnesium, zinc, bismuth and brass in order. After the distance of 3μ is exceeded, the gas comes into play, but there is always a certain distance, evidently corresponding to the mean free path, through which the sparking potential remains constantly at 350 volts. With a pressure of 1 centimeter of mercury in air this distance extends as far as 75μ. In hydrogen this constant potential is lower, and in carbonic acid it is higher than in air, being about 420 volts. When this "minimum gas potential" reaches its limiting spark-length, the potential increases steadily with a further lengthening of the spark gap, and is proportional to its length. The author operated with one spherical and one plane electrode, and measured the distances with an interferometer.—G. M. Hobbs, Philosophical Magazine, December, 1905.

* Compiled by E. E. Fournier d'Albe in the Electrician.

SCIENCE NOTES.

That India rubber is extensively adulterated during the processes of manufacture is a well-known fact, but that the crude material is "faked" by the natives at the time it is collected is not common knowledge. Yet such is the case, and the natives are stated to be exceptionally expert in this traffic. The classes mostly adulterated are the darker brands. When the tree is tapped, the raw material is collected first in a suitable receptacle. It is then of the consistency of treacle, and in order to cause the sap to coagulate it is poured upon a bamboo pole, which is slowly revolved over a fire so that a large sphere of rubber is produced. It is during this stage that the natives adulterate the rubber. White cereals of any description are ground to the consistency of flour, and as the pole carrying the rubber is revolved, it is thickly sprinkled with the powdered grain. It is practically impossible to discover traces of this "faking," as after manufacture the product is exactly similar to the finest qualities of white rubber.

Fourcroy studied the nature of "litharged" wine, Berthollet (1801) the methods of preserving water for long voyages, Chevreul (1846) various chemical reactions which explain the hygiene of populous cities, and (1856, 1862, 1870) methods of preparing and preserving food; Graham and Hofmann reported upon the use of acetate of lead in sugar refining (1850), upon the London water supply (1851), and upon the adulteration of pale ales with strychnine (1882); Dumas was interested in many sanitary matters and made, among others, reports on the mineral waters of France (1851), on the water supply of Paris (1859), on the treatment of sewage (1867), and on the preservation of food (1870–72); Wurtz was for a number of years president of the Comité consultatif d'hygiène, and a year before his death was president of the Société de médecine publique. His investigations and reports on sanitary subjects are numerous—on the disposal of the waste from distilleries and sugar-refineries, on the colors employed on German toys and in articles of food, on the adulteration of wines, etc.

Except in the case of *Sporodinia grandis*, and perhaps one or two other species of Mucoraceæ, mycologists have experienced great difficulty in securing the zygosporic stage of these fungi. The recent paper by Blakeslee, announcing the conditions governing zygosporic formation in this family, seems to open a field for investigation wholly novel and suggestive. The substance of his results is that this family may be divided into two principal categories, designated, respectively, as homothallic and heterothallic, these terms corresponding to monoecious and dioecious forms among higher plants. *Sporodinia grandis* belongs to the homothallic type, both gametes in every union developing from the same thallus. *Rhizopus nigricans* belongs to the second and larger class, the heterothallic type, in which the two gametes are invariably the product of two mycelia, which mycelia are sometimes of diverse vigor. When in culture, the two strains, as they are termed, grow together, zygospores are abundantly produced along the lines of contact. These are the striking results of this important paper; but other related physiological facts have been observed, and only further investigation can tell whether this is a special case of gametic union in the fungi, or whether similar phenomena may be found to be characteristic of other groups where there is gametic union.

Nothing should be said against classical education for those who can be benefited by it. The second aorist, the verbs in *mi*, the ethical dative, and the subjunctive by attraction have satisfied and will continue to satisfy many a hungry soul. But we have discovered recently two important facts: first, that in this scientific age of ours there are intellectual stomachs that revolt at such a diet and absolutely refuse to assimilate it; second, that the greatest error in our present system of education is the attempt to create a uniform type of mind, to turn out large numbers all equipped with the same stock in trade. Every encouragement should be given to train the best that is in each individual and not to obtain an average of mediocrity. It is a pleasure to note that the teaching of the kindergarten, the introduction of manual training, the increase of science study are all tendencies in the right direction. There is, however, a realm of educational work which is based upon the economic and industrial needs of the nation. With advancing civilization, with the luxuries of yesterday becoming the conveniences of to-day and the necessities of to-morrow, with our products reaching every civilized market on the globe, with competition in all lines of activity growing keener and keener every day, it is seen that local experience, even though deep and thorough, counts for little in the world-wide industrial competition. A basis of judgment and of practice must be obtained that shall be universally true—this has been found in the study of science, both pure and applied.

The biologists have great problems on hand for solution. The nineteenth century work made it clear that all the forms of vegetable and animal life of to-day are the product of slow changes in form and functions of living things reaching back millions of years. The successions of some forms were well worked out and the principle established. We call it evolution and everybody nearly believes that this represents the truth in the matter, but how these changes occur and what necessitates them remain as mysterious as ever. Darwin spoke of natural selection. There were all sorts of variations in progeny, and the ones best fitted to the environments survived, but he gave no reason *why* there should be variations, and this is the great question to-day. Many are at work to discover this, and some who have worked in this line have stumbled upon some very unsuspected facts. There has been assumed that like would produce like, and that heredity could and would account for abnormal structures when parents for any reason through new environment had acquired new habits or new structures of any kind. Now it has been shown that such changes of structure or of habit seldom if ever appear in the progeny. For instance, no matter how many generations of mice have their tails cut off each new mouse has the same old length of tail. Each lamb has as many tail vertebræ as did those of hundreds of years ago, though all lambs have their tails cut off when young. Such acquired character is not inherited. Nature pays no attention to any changes save such as she herself initiates, and the conditions she herself adopts remain to be found out. Sometimes she makes monsters and sometimes geniuses, but never by external environment, always *de novo*. This throws overboard the principle good and thoughtful men have so long cherished, that the good habits of one generation would be a hereditary possession of the next. The conditions for heredity are now a most absorbing study among some of the foremost biologists. It is suggestive that at this late day such a reversal of opinion on this question has come about and that the question has been run down to cellular structure and molecular arrangement. It will hardly be gainsaid that a knowledge of the proper conditions for changing forms, functions, habits and motives of living beings will be of priceless value to the race, and this work comes to the twentieth century.

ELECTRICAL NOTES.

A series of tests has been carried out for some time in Switzerland by one of the leading electrical firms, the Oerlikon Company, under the auspices of the government railroads, upon the use of alternating current for electric locomotives. Monophase current at high tension is employed here, and at present the tests are made with two locomotives. These are of two different kinds, and the first one is equipped with apparatus to transform the alternating current into direct current. The latter current is sent into the motors of the locomotive. Each of the motors is rated at 220 horsepower. The first locomotive, weighing 46 tons, carries four driving axles. Using 400 horse-power, it makes a speed of 25 miles an hour up to 35 miles an hour. As regards the second locomotive, it runs entirely by alternating current. The line current of 15,000 volts is lowered by transformers to 750 volts for the motors. About 42 tons is the weight of the locomotive and it has about the same power and speed as the first one. Current is taken from an overhead wire, with different experimental forms of trolley. On the Seebach-Affoltern trial trips have been made with 150 and 200-ton trains, and in 215 days the trains made 1,746 trips. In general, the results of the tests have been successful, and afford many points in regard to the working of alternating current for locomotives.

The Compagnie de l'Industrié Electrique is carrying on a series of experiments at the works near Geneva regarding the use of direct current at unusually high tension. These tests, which seem to show the possibility of using tensions which are two or three times as high with the direct current as with alternating current, in connection with the well-known series system of transmission over long distances, are likely to be of great importance from a practical point of view. One of the largest plants which is now operated on the high-tension direct-current system is the St. Maurice-Lausanne hydraulic transmission plant which has been running successfully for some years past. The experiments may lead to a greater development of this system, and show that current can be transmitted at a low cost to great distances. An important point is that underground cables can be used for high tension without showing the great disadvantages which we find with alternating current. These tests have been carried on in the presence of leading engineers from different countries. For the first time we are able to observe the effects of direct current at tensions which reach 100,000 volts between the line and ground. This represents, in reality, a tension of 200,000 volts between two wires. The highest tensions which have been utilized in Europe with alternating current up to the present do not exceed 60,000 volts, and even in this case engineers consider it too high for use in practice. The result of the tests is therefore to be awaited with interest.

As regards the electric plants now in service or in project at Lima, Peru, or in the neighborhood of that city, we note the following points. The system of electric railroads and tramways near the city has much increased since 1904. The electric road connecting Lima with the port of Callao is now running well, and also the line which connects the city with different seaside resorts as far as Chorrillos. Owing to the absence of dust, this line has taken nearly all the

traffic away from the steam railroad. It is proposed to build a second electric line which will also run to Chorrillos and will compete with the former. The second line is to be built by a German syndicate. On the other hand, the city tramway company of Lima has made an arrangement with the municipality by which it is to electrify its lines within the space of two years, at the same time increasing the lines by three miles of track. Electric automobile hauling wagons are now used to transport part of the freight between the custom-houses of the port of Callao and of Lima. These wagons have given very good results so far, and they circulate in all the streets of the city. As regards aerial telegraphy, it appears that the Peruvian government lately made a contract with a German company for establishing an aerial telegraphy system between the port of Iquitos and Lima. To erect the intermediate stations will no doubt require some time, seeing that these posts must be constructed in an almost uninhabited region on the eastern slope of the Andes. Among the new electric enterprises in Peru may be mentioned the electric lighting of the cities of Huacho and Chiclayo.

ENGINEERING NOTES.

Until the recent development of the Portland cement industry in the United States, the greater quantity of concrete work was done with the natural cements, of the Rosendale or Roman classes, which have always been obtainable in this country, of excellent quality. Portland cement was formerly used only where special hardness, or strength or resistance to abrasion was required, but now the low cost of Portland has caused a great extension of its use. There are, besides, instances where, in the inside of a large mass, a natural cement has failed to set, even after many years, but no such failure of Portland cement has been recorded. In recent years, the manufacture of all kinds of cement has been greatly improved and good concrete can be made from either natural or Portland, but where exposure to the weather, or great resistance to abrasion is necessary, Portland cement is generally preferred.

Numerous tests have been made by eminent authorities upon gas-producers in order to ascertain the actual heat efficiency. Mr. Dugald Clerk, in a lecture delivered before the Institution of Civil Engineers in 1904, gave the results of some tests carried out for him by Mr. M. Atkinson Adam, B.Sc., on two Dowson suction producers, one adapted for a maximum working load of 40 B. H. P., generating about 3,000 cubic feet of gas per hour; the second adapted for a maximum working load of 30 B. H. P., generating about 2,300 cubic feet per hour. The heat efficiency of the 40 B. H. P. plant was found to be 89 per cent, while the 30 B. H. P. plant showed an efficiency of 86 per cent. The thermal efficiency of the gas engine is very much greater than that of the steam engine, the highest efficiency obtained—so far as the author is aware—being about 33 per cent on the brake horse-power, while the efficiency of many engines of different sizes and designs varies between 20 and 30 per cent.

Freyn has made the following calculation, assuming a new blast furnace plant of two 400-ton blast furnaces, situated in the immediate vicinity of a large city and having the ordinary facilities for water supply and for handling the raw and finished material. Assuming both furnaces in good operation and assuming a coke consumption of 1,900 pounds per ton of pig iron, there will be required $800 \times 1,900 = 1,520,000$ pounds of coke per day. This quantity of coke produces approximately 110,000,000 cubic feet of gas in 24 hours, or per ton of pig iron $110,000,000 \div 800 = 137,000$ cubic feet of gas. The losses on the top of the furnaces may amount to approximately 5 per cent, so that 130,000 cubic feet of gas per ton of pig iron produced in 24 hours could be obtained. The average heat value of this blast furnace will be about 90 B. T. U. per cubic foot. The total quantity of gas available for the various purposes in this blast furnace plant amounts to $130,000 \times 800 = 104,000,000$ cubic feet of gas per 24 hours, or 4,350,000 cubic feet per hour, having a total heat value of 391,500,000 B. T. U. Modern double-acting gas engines of large capacity working on the four-cycle or Otto principle, built with the latest improvements and using high compression of mixture, consume less than 9,000 B. T. U. per hour per brake horse-power at full load capacity. The total quantity of gas produced by two blast furnaces of 400 tons capacity each, when used in gas engines for generating power, would operate at least $391,500,000 \div 9,000 = 43,500$ horse-power. If, therefore, all the gas generated by a blast furnace plant could be used for producing power, there would be available over 50 horse-power per ton of pig iron produced per 24 hours. This quantity of 4,350,000 cubic feet of gas per hour will be divided for the various purposes of the blast furnace plant as follows: One part of the gas is used for heating the hot blast stoves, another for operating gas blowing engines and there is gas required for the auxiliary machinery, such as pumps, hoists, coke and ore-handling machinery, power transmission, compressed air, pig-iron casting machinery, and for lighting the entire blast furnace plant; some of the gas is also necessary for operating gas engines serving the gas cleaning plants and a certain percentage may be counted for losses in the piping in the engines, the gas cleaning plant, etc. It will be seen that the total quantity of gas necessary for the operation of the blast furnace plant itself amounts to approximately 50 per cent of the total quantity generated, leaving a little less than 50 per cent available for useful work outside of the blast furnace plant itself.

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